THE RELATIONSHIP BETWEEN ATTITUDES TOWARDS SPECIFIC MATHEMATICS TOPICS AND ACHIEVEMENT IN THOSE DOMAINS

by

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B.A., The University of British Columbia, 1975

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS

in
THE FACULTY OF GRADUATE STUDIES
(Department of Mathematics and Science Education)

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

December, 1991

ABSTRACT

The purpose of this study was to investigate the nature of the relationship between high school students' attitudes towards particular mathematics topics and their achievement in those areas. In order to examine this relationship, data collected by the 1990 British Columbia Mathematics Assessment concerning students in Grade 7 and Grade 10 were analyzed. This assessment involved over 37 000 students at the Grade 7 level and over 31 000 Grade 10 students. Data concerning students' perceptions as to the importance, difficulty, and likeability of various mathematics topics were collected by the assessment. Achievement scores based on student performance on a 40-item, multiple-choice test of mathematical ability were also obtained. Each of the domains of the British Columbia mathematics curriculum were represented on the achievement test. Achievement items were also constructed at three cognitive behaviour levels: computation, comprehension, and application/problem solving.

Geometry and data analysis were the two domains of the mathematics curriculum which were the focus of this work. The data relating to these topics were analyzed through the use of chi-square analysis. Matrices were designed which compared students' perceptions of geometry and data analysis with their achievement in those domains. Each of the three components of attitude–difficulty, importance, and likeability–were treated as independent variables. Chi-square values were determined for each matrix and an analysis of the patterns exhibited by the cells was also undertaken. With one exception, each matrix had a chi-square value which was significant at the 0.0001 level. The remaining matrix was significant at the 0.001 level.

An examination of the Grade 10 data indicated that a significant relationship between students' attitudes towards geometry and data analysis and students' achievement in those domains existed. The number of students who considered geometry or data analysis to be important, easy, or likeable and who also obtained good scores on the achievement portion of the assessment was greater than the expected value for those cells of

the matrices. Likewise, the number of students who indicated that geometry or data analysis was not important, was difficult, or disliked the topic and who also obtained low achievement scores was greater than the expected value. Similar patterns were observed when students' overall achievement in mathematics was compared with their attitudes towards data analysis and geometry.

Students in Grade 7 generally achieved higher scores in the mathematics assessment and held more favourable views towards data analysis and geometry than did students in Grade 10. However, results showed that the relationship between each of the components of attitude and achievement in geometry and data analysis followed trends similar to, but not as strong as, those found for students in Grade 10.

For the purposes of this study, the Grade 10 data were also separated into two groups. The data concerning students enrolled in the more challenging Mathematics 10 course were compared with the data relating to students enrolled in the less difficult Mathematics 10A course. Students enrolled in the Mathematics 10 course achieved higher scores and held more positive views towards data analysis and geometry than did the students enrolled in Mathematics 10A. The relationships between each of the components of attitude studied and achievement within each of the domains, however, were similar for both groups of students.

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ACKNOWLEDGEMENT

I wish to thank the members of my thesis committee, Dr. David Robitaille, Dr. Mike Marshall, and Dr. Walter Szetela for their guidance. It has been a privilege for me to work with them.

I would also like to thank my family for their support, patience, and encouragement.

CHAPTER 1
INTRODUCTION

Background

The teaching of mathematics involves an awareness of both the affective and the cognitive domains. An element of the affective domain which may have a significant relationship to the learning of mathematics is attitude. Although attitude has been defined in many different ways, a common theme in most definitions of the term is that an attitude can influence and determine the direction of an individual's behaviour. Thus, attitudes, which may predispose an individual towards certain behaviours, can play an important role in the process of learning mathematics. It has been speculated that attitudes may affect the amount of effort an individual is willing to make in order to learn mathematics, may influence the selection of specific mathematics courses, and may be linked to individual differences in learning mathematics (Fennema & Sherman, 1976). Attitudes have also been viewed from the reverse perspective where they have been seen to be an outcome of the process of learning mathematics (Jackson, 1990; Newman, 1984).

Numerous investigations have been undertaken to determine the nature and strength of the relationship between the learning of mathematics and the attitudes of students towards the subject. In 1970 and 1976, Aiken conducted surveys of the literature concerned with attitudes and performance in mathematics. Based on the results cited in this literature, he concluded that there is a low to moderate correlation between these variables (Aiken, 1976). More recent research has suggested that there might be a stronger association than was previously indicated and that this relationship between attitude and mathematics achievement is a complex one involving many different factors. Two studies conducted since the mid-1970's found that attitude, when treated as a single entity, had a significant, moderate correlation with student progress in mathematics (Campbell & Schoen, 1977; Tsai & Walberg, 1983).

However, with the development of new instruments for measuring specific dimensions of attitude (Fennema & Sherman, 1976; Sandman, 1980), the emphasis in recent studies has been on investigating particular aspects of attitude rather than on working with attitude as a single variable (Bassarear, 1987; Brassell, Petry & Brooks, 1980; Cheung, 1988; Kifer & Robitaille, 1989; Newman, 1984; Taylor & Robitaille, 1987). Anxiety, difficulty in learning mathematics, enjoyment of mathematics, students' self-concept of their ability to learn mathematics, and the value of mathematics in society are all attributes of attitude which have been linked to achievement in mathematics (Brassell, Petry & Brooks, 1980; Cheung, 1988; Hembree, 1990; Reavis, 1989; Taylor & Robitaille, 1987). However, the strength of the relationship to achievement was not found to be the same for each of these components. Although the findings were not consistent across all studies, in general, the component which accounted for the greatest variance in achievement was self-concept of ability (Brassell, Petry & Brooks, 1980; Cheung, 1988).

Research has also been undertaken to determine if the link between attitude and mathematics achievement varies depending upon specific characteristics of the students involved. Grade level (Hembree, 1990; Newman, 1984; Taylor & Robitaille, 1987), intelligence (Minato & Yanase, 1984) and mathematical ability (Brassell, Petry & Brooks, 1980; Hembree, 1990) have all been found to be associated with the degree to which attitudes interact with mathematics performance.

The relationship between attitudes and mathematics achievement appears to be an intricate one. Although the research tends to support the view that attitudes are linked to the learning of mathematics, it also suggests that to make generalizations about all students and the impact of attitude on their learning of mathematics may be inappropriate. While it is important to recognize that attitude may be a factor in the learning of mathematics, it must also be recognized that its influence varies depending upon the circumstances. As noted previously, the individual student and the specific aspect of attitude under consideration both appear to be important elements in this relationship.

The relationship between attitudes and mathematics performance may also depend upon the specific mathematical topic under study. However, little is known about this possible relationship. Several large scale studies of mathematics achievement have shown that student performance varies over different topic areas. The 1985 British Columbia Mathematics Assessment (Robitaille & O'Shea, 1985), the 1986 Fourth National Assessment of Educational Progress in the United States (Brown, Carpenter, Kouba, Lindquist, Silver & Swafford, 1988a, 1988b) and the Second International Mathematics Study (Robitaille & Garden, 1989) all report that student achievement in mathematics is not the same for all areas of the curriculum.

There has also been some descriptive statistical evidence that suggests that students have different attitudes toward different parts of the mathematics curriculum (Hogan, 1977; Kifer & Robitaille, 1989; Robitaille and O'Shea, 1985). However, there appears to have been little research done to determine the nature of the relationship between attitudes and the learning of these specific mathematical topics. Increased knowledge in this area would lead to a greater understanding of the mechanism by which student achievement and student attitudes interact.

Statement of the Problem

During the 1989-90 school year, the Fourth British Columbia Mathematics Assessment was conducted. Approximately 108,000 students and 4500 teachers from Grades 4, 7, and 10 took part. The major focus of the assessment was to investigate the level of student achievement in mathematics and the perceptions of students and teachers towards topics relating to the learning of mathematics (Robitaille, in press). Thus, this assessment contained data which could be used to investigate the connection between achievement in mathematics and attitudes towards specific areas of the mathematics curriculum.

The contents of the achievement portion of the British Columbia Mathematics Assessment reflected the domains and objectives of the mathematics curriculum in that province. The mathematical content for each grade level was partitioned into major strands which were then divided into several topics. For Grades 4 and 7 these strands were Algebra, Data Analysis, Geometry, Measurement, Rational Numbers and Whole Numbers. The strands for Grade 10 were the same except that the Whole Numbers and Rational Numbers sections were combined under the single heading entitled Numbers & Operations. For each of these major strands, questions were developed at three cognitive levels: computation, comprehension, and application.

In the section dealing with background, attitudes, and opinions, students and teachers were asked to indicate their views on many of the strands evaluated in the achievement section of the study. They were questioned on their perceptions of the importance, enjoyment, and difficulty of learning or teaching such topics as geometry, trigonometry, data analysis and fractions. As a result, information regarding students' attitudes towards certain domains of the mathematics curriculum and their achievement in those domains was obtained by this assessment.

The general purpose of this study, then, was to use data from the 1990 British Columbia Mathematics Assessment to investigate the nature of the relationship between high school students' attitudes towards particular mathematics topics and their achievement in those areas. Information from the geometry and data analysis domains in Grade 7 and 10 was used to generalize about the nature of this relationship for students at these age levels. These particular topics were chosen because they are areas common to the course of study of both Grades 7 and 10 and within each of these topics there are many objectives which are common to both grades. Also, the 1985 British Columbia Mathematics Assessment (Robitaille & O'Shea, 1985) determined that students' performance in geometry was poor at all three grade levels and that students and teachers considered geometry to be the least important of a group of ten mathematical topics. This weak performance and the suggestion of a possible connection to attitude made geometry a topic of particular interest.

The specific questions addressed by the study are as follows:

1. What relationships exist between students' attitudes towards the geometry and data analysis domains of the mathematics curriculum and students' achievement in those domains?

2. What relationships exist among students' overall mathematics ability, their achievement in the geometry and data analysis domains, and their attitudes towards these topics?

3. What differences, if any, exist in the nature of the relationships in questions 1 and 2 among students at different grade levels?

4. What differences, if any, exist in the relationships in questions 1 and 2 among students in the same grade who are enrolled in different mathematics courses?

CHAPTER 2

REVIEW OF THE LITERATURE

Research into the relationship between attitudes and mathematics education has been conducted from a variety of perspectives. This review of the literature focuses on those studies which were concerned with students' attitudes towards mathematics and how they relate to achievement in mathematics. The emphasis is on those works which dealt with students learning mathematics at the high school level.

The first part of the review discusses the term "attitude" and its usage in the literature. The next section is organized on a chronological basis. Changes in this field of study have been made during the past few decades and these changes are reflected in the literature. The latter portion of the review focuses on the results of recent major studies, and on the work done in some specific content areas.

Use of the term "attitude"

There is no universally accepted definition of the term "attitude" and, in the literature cited in this review, little attempt was made by the authors to explain its meaning. A formal definition was given in only two research reports. One definition, included in a footnote and prefaced with the explanation that "... there is no standard definition of the term attitude...", stated that, in general, attitude "...refers to a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or another person" (Aiken, 1970). In another work, attitude was referred to as "...affectively toned perceptions of situations in which mathematics is learned as well as to views of mathematics as a subject" (Cheung, 1988). Although there has been considerable work done towards the development of a definition of attitude (Allport, 1967; Anderson, 1988; Hart, 1989; Shaw & Wright, 1967), the discrepancies between the two definitions mentioned previously indicate that there is no consensus amongst researchers in mathematics education as to the precise meaning of this term.

In most of the studies cited in this review, it seems to have been assumed that, when the word attitude is used, there is a general, but unstated, understanding of its meaning. Other terms related to the affective domain, such as opinions, beliefs, emotions, and values, have also escaped definition.

A structure for distinguishing between these various terms has been developed by McLeod (1989). McLeod has indicated that beliefs, attitudes, and emotions are terms that describe different aspects of the affective domain. Each of these terms represents different levels of cognitive involvement. Beliefs, attitudes, and emotions represent a range of responses with "...increasing affective involvement, decreasing cognitive involvement, increasing intensity, and decreasing stability" (p.246).

Beliefs about mathematics are considered by McLeod to be the most stable of the three terms and he divides beliefs into two general categories. One set of beliefs concern those about mathematics as a discipline. A second set of beliefs deals with how students view their own relationship towards mathematics. This second group of beliefs involves a greater affective response than the first group, and it includes such concepts as self-confidence and self-concept of ability.

McLeod suggests that attitudes represent those '...affective responses that involve positive or negative feelings of moderate intensity and reasonable stability" (p.249) and are resistant to change. Whether or not a student likes a particular topic would be an example of an attitude towards mathematics. McLeod considers attitudes to be stable enough to be able to be measured through the use of a questionnaire.

Emotions, however, are the least stable of the three terms and cannot be measured in this traditional manner. Emotions involve feelings that are more intense than those represented by attitudes and beliefs and these feelings may change quickly. As an example, McLeod suggests that a student might feel frustrated while trying to solve a problem. This feeling will often disappear once the problem is solved.

The situation described above suggests that, because the term attitude has not been explicitly defined in all of the research, the studies concerning its relationship to achievement in mathematics may lack validity. However, in most works attitude has been defined, in an indirect manner, by the instruments used to measure the term. Self-reporting scales, which require subjects in a study to report on a variety of items, were the most commonly used means of assessing attitude. In any particular study, the items selected for this purpose would then represent the definition of attitude for that piece of research. The findings of these works, however, could only be related to attitude as defined in this context.

In more recent studies, some researchers have chosen to separate attitude into a variety of components, such as self-concept of ability or motivation in mathematics, and have then defined these individual characterisics. However, the defintion of these terms for the purposes of the research are, again, dependent upon the instruments used to evaluate them. As Kifer (1990) explained:

> [T]hose who do attitude research ... must face the fact that there is no one right definition of an attitude and no one right way to measure [it]. ... In a strict sense there is a difference between problems of defining attitudes and those of trying to know what has been measured (p. 4). ... Instead one should provide justifications and strong specifications for what is done regardless of the labels that are attached to our measures (p. 6).

Early Studies

In his book, *Life in Classrooms,* which was first published in 1968, P. W. Jackson (1990) presented the “common sense” arguments which are sometimes given to link academic success with positive attitudes towards school. He referred to the view held by some psychologists that positive and negative reinforcement will produce corresponding positive and negative feelings. The good grades and positive feedback received by some students should elicit a different view of schooling than that held by students who obtain low grades and negative personal feedback. Thus, achievement is a predictor of attitude.

Jackson also discussed this relationship from the reverse direction. In order to do well in school, or in any job, one must want to do the necessary work. Therefore, accomplishment in school depends upon one's attitude towards the task.

These same arguments could also be applied to the study of the specific content area of mathematics. However, despite the apparent logical basis to the above reasoning, early research into attitudes and mathematics achievement did not produce consistent significant links between these variables.

In 1970, a major survey by Aiken of the research into attitudes towards mathematics was published. He also presented an updated study in 1976. Both of these works contained sections discussing attitude and achievement. The research cited produced a group of results ranging from no apparent relationship to significant correlations. In general, however, Aiken reported that low to moderate correlations between attitude and mathematics achievement were found.

In the conclusions of his works on attitude, Aiken expressed concern over the attitude measurement instruments and the statistical methodology being used at the time. He stated that:

> There are too many "home-grown", unstandardized attitude scales, and too many researchers have not bothered to become informed about the uses of ... methodology. ...Designers of attitude instruments should begin to provide evidence of the extent to which an instrument is a precise measure of attitude and is sensitive to changes in attitude (Aiken, 1976, p. 302).

An example of the difficulty involved in investigating attitudes at that time can be found in the doctoral work of the following individuals who were not referred to in Aiken's material. Burbank (1970) and Caezza (1970) each used the Dutton Mathematics Attitude Scale to study the relationship between students' attitudes toward mathematics and students' achievement in mathematics. Burbank worked with 411 seventh grade pupils from a single junior high school. The Pearson correlation was used to test four null hypotheses regarding students' attitudes toward mathematics as related to their achievement in mathematical reasoning, achievement in mathematical concepts, achievement in mathematical computations and overall mathematical achievement. Statistically significant results were found in all four cases.

In contrast, Caezza did not find any correlations of a practical significance between student achievement and teacher or student attitude. The subjects in his study consisted of 2765 pupils from Grades 2 through 6, and all of their teachers, from a single district in New York State. In addition to presenting the results of his research, Caezza concluded that the Dutton Arithmetic Attitude Scale was inadequate as an instrument for linking attitude to academic variables. While the difference in the findings in the work of Caezza and Burbank could be due to a variety of factors, it does reflect the uncertainty of the research at that time.

Measurement Scales

In the mid-1970's, two attitude scales were developed which have since gained wide-spread acceptance by researchers. Richard Sandman (1980) designed the *Mathematics Attitude Inventory* (MAI) to measure the attitudes of students in Grades 7 through 12 towards mathematics. The MAI consists of 48 statements about mathematics which are divided into six groups measuring different constructs of mathematics attitude. These categories are: perception of the mathematics teacher, anxiety toward mathematics, value of mathematics in society, self-concept in mathematics, enjoyment of mathematics, and motivation in mathematics.

In order to gain information regarding the learning of mathematics by females, Elizabeth Fennema and Julia Sherman (1976) developed the *Fennema-Sherman Mathematics Attitude Scales*. They wanted an instrument which would go beyond the measure of global attitudes, one which would define specific dimensions related to the learning of mathematics. Nine affective domains were established. Some of these, such as the Teacher Scale, the Mathematics Anxiety Scale, the Effectance Motivation Scale in Mathematics and the Mathematics Usefulness Scale, are similar to ones presented by

Sandman, whereas others, such as the Mathematics as a Male Domain Scale and the Mother/Father Scale, were designed to study the relationship of gender to attitude and achievement. The remaining domains were the Attitude toward Success in Mathematics Scale and the Confidence in Learning Mathematics Scale.

Both of the above instruments use a Likert-type response format where students choose from a four- or five-point scale ranging from strongly agree to strongly disagree. Statistical evidence supporting the validity of the instrument has been supplied by the authors of each of these scales (Fennema & Sherman, 1976; Sandman 1980).

Mid–1970's to the Present

The research done since the mid-1970's has been influenced by the development of the previously mentioned scales. These instruments have frequently been used or they appear to have been the model for the design of other attitude scales. While some researchers continued to treat attitude as a single variable, many have instead worked with specific dimensions of attitude.

In addition to separating attitude into its various components, studies have also been done which divide subjects into different groups. Grade level and mathematical ability are some of the classifications which have been used. Since the development of the Fennema-Sherman scale there has also been increased interest in gender and its relationship to attitudes and achievement. However, it is not the intent of this review to survey that latter collection of material.

Components of Attitude

Recent research has focused more on studying the components of attitude than on working with attitude as a unitary concept. Two aspects of attitude which have sometimes been associated with achievement are self-concept and anxiety. While these terms have not been defined in the same manner throughout the literature, there does seem to be a common understanding of the meaning of the terms. In the MAI scale, Sandman defined self-concept in mathematics as "a student's perception of his or her own competence in mathematics" and anxiety as "the uneasiness a student feels in situations involving mathematics" (p. 149). None of the scales in the Fennema-Sherman attitude inventory are specifically entitled "self-concept", but this idea is incorporated into the other dimensions. Mathematics anxiety is defined in a manner similar to Sandman. Some of the findings relating to anxiety and self-concept are discussed in the following material.

The role of anxiety was investigated by Hembree (1990) who used meta-analysis to examine the findings of 151 studies concerned with mathematics anxiety. Based on this survey, Hembree concluded that mathematics anxiety contributes to lower performance in mathematics. However, this relationship was not found to be reciprocal. Lack of success in mathematics did not appear to cause mathematics anxiety.

Using the Mathematics Attitude Inventory, Brassell, Petry, and Brooks (1980) undertook an investigation of mathematics achievement as it relates to ability grouping and student attitudes towards the subject. Their research also included a study of the relationship of anxiety and self-concept to the learning of mathematics. Their findings on the role of grouping will be discussed later in this review in the section entitled Age and Ability Levels.

Brassell, Petry, and Brooks worked with 714 Grade 7 pupils representative of five junior high schools in a suburban community in the United States. Scores from components of the California Test of Basic Skills and its total score were used to measure achievement. The findings on anxiety indicated weak, negative, correlations ranging from -0.27 to -0.30 for the relationship between mathematics anxiety and mathematics applications, concepts, computations, and total mathematics score. Moderate, positive correlations of 0.35 to 0.40 were found for mathematics self-concept and the same four measures of achievement. In general, as self-concept decreased, anxiety increased.

A major study by Newman (1984), however, reached a different conclusion. In 1971, a longitudinal study initially involving 255 children who were enrolled in kindergarten in four Minneapolis schools was begun. These students were again monitored in Grades 2, 5, and 10. By Grade 10, only 103 students remained in the study. Newman began the report on his work with a detailed discussion of the research that had been done into the relationship between academic achievement and self-concept of ability. He concluded that the "...findings support both directions of causality between children's achievement and self-perceptions of ability" (p. 858). That is, self-concept of ability could affect a child's academic achievement and, in turn, academic achievement could affect a person's self-concept. These conclusions lend support to the "common-sense" arguments regarding attitude and achievement presented by Jackson.

The purpose of Newman's study was to examine this connection within the area of mathematics and to do so using an improved longitudinal design. By using more than two time periods, the intention was to avoid any hidden curvilinear relationships. Achievement was measured by the score on a series of tests, and the self-concept measure was based upon student Likert-type ratings of mathematics performance.

Using path-analysis, Newman concluded that, between Grades 2 and 5, mathematics achievement influenced students' perceptions of their ability. However, this influence did not operate in the reverse direction. The effect of self-concept on achievement was almost zero. Between Grades 5 and 10, self-concept again did not have any significant causal relationship to achievement. Depending upon the model he constructed, Newman found that between these two grades achievement had either a low or no causal effect on self-concept. It was also determined that the accuracy of these student self-ratings relative to actual ability increased between Grades 2 and 5 but did not do so in later years, whereas achievement remained stable throughout these years. Newman's work is one of the few studies to investigate if there is a two-way relationship between attitudes towards mathematics and the learning of the material.

Campbell and Schoen (1977), in their investigation of teacher behaviours, also studied the relationship between attitudes and mathematics achievement. The subjects were 1602 pre-algebra students attending school in Oklahoma. Using a 3-point scale, students reported how much they liked mathematics and this response was used to assess their attitude towards mathematics. Achievement was determined by the student's grade in the subject. A correlation of 0.34 between these grades and attitude was found. However, as attitude was defined in a narrow context in this study, these results apply only to the concept of 'liking' mathematics rather than to a broader definition of attitude.

The results of major assessments which have also considered the role of specific components of attitude in their studies will be discussed in a subsequent section entitled Large-Scale Assessment Studies. However, the overall body of work done since the mid-1970's which has focused on the particular components of attitude has been more consistent in its findings than the work done prior to that time. Although the findings are not the same across all studies, in general, the research has indicated that there is a significant, moderate correlation between various dimensions of students' attitudes towards mathematics and students' achievement in mathematics.

Age and Ability Levels

In addition to looking at different attitude components, researchers have also been interested in determining if the relationship between attitude and mathematics achievement varies with the characteristics of the subjects concerned. The grade level of the students and their level of academic ability are two areas which have been studied.

Newman, for example, in the study cited previously in this review, indicated that the strength of this relationship between performance in mathematics and students' attitudes is linked to the grade level of the students. The Third British Columbia Mathematics Assessment was a major study which also worked with students in different grade levels. Its findings will be discussed in the section dealing with large-scale studies.

Other researchers have grouped subjects according to academic ability. In a study of over 800 Grade 8 pupils attending three schools in Japan, Minato and Yanase (1984) placed students into three categories based on their scores on an intelligence test which has been used extensively in Japan. For statistical purposes, attitude was treated as a single entity and its measurement was based on the results of two attitude scales developed in Japan. Achievement was measured by tests which covered the topics of numbers, linear equations, and inequalities.

The purpose of this study was not to determine if attitudes affect achievement; but rather to determine what is the influence of ability on performance if attitude is assumed to influence learning. Based on their findings, Minato and Yanase concluded that the effect of attitudes on mathematics achievement for students who ranked low on the intelligence test was greater than for those who ranked in the middle range and greater still than for those with a high ranking.

Brassell, Petry, and Brooks also examined the impact of ability grouping. In their study, students had already been assigned by the school district to one of three different levels based on a measure of their mathematical ability. Within each of these district levels, teachers were asked to divide the pupils into three groups, (high, medium and low), according to their ability.

Brassell, Petry and Brooks reported that, among each of the three district levels, there were significant differences on five out of six attitude scales. On the value of mathematics in society and anxiety towards mathematics scales the differences were weak while moderate differences were reported on the enjoyment of mathematics and attitude towards the teacher scales. Strong, significant differences were reported on the self-concept scale. Motivation was the only non-significant scale.

For each district level, the mean scores on the attitude scales within the high, medium and low sub-groups were given. These figures indicate that, for each district level, anxiety increased and self-concept decreased as the ranking of the student went from high to low. It is interesting to note that the students with the lowest self-concept and the highest anxiety level were the low-ranked students within the medium level classes. In contrast to the findings of Minato and Yanase, which indicated that attitude had the least effect on students of high intelligence, Brassell, Petry, and Brooks reported that the high-ranked students in the high-level district group had the lowest anxiety level and the highest self-concept.

Hembree's study also investigated the impact of anxiety on students working at different levels and his findings were similar to those of Brassell, Petry, and Brooks. When subjects were compared based upon their ability, high ability students were found to have lower levels of anxiety than average to low ability students. No difference was found between the average and low ability groupings. It was also determined that the level of anxiety for students increases throughout junior high school, peaking and levelling off near Grades 9 and 10.

In a longitudinal study on sex differences in mathematical reasoning ability, Benbow and Stanley (1982) worked with students in the United States who had scored in the upper five percent on the national norms for a standardized achievement test. In this research, attitude was defined as a composite score on a scale which consisted of student ratings of their views on the importance of mathematics for obtaining a job, whether or not they liked mathematics, and how they ranked mathematics relative to other high school subjects. For these high-ability students, Benbow and Stanley found that

> ... there does not appear to be much relationship between attitudes toward mathematics and achievement in mathematics in a high-aptitude group, unless the variables measured in this study were inadequate indicators of attitudes toward mathematics. ... For example, [it has been] demonstrated that attitude toward mathematics involves several distinct components (p. 617-618).

These results, like those of Minato and Yanase, were based on the study of attitude as a single variable and they do not coincide with the findings of Hembree or Brassell, Petry, and Brooks whose works were based on the study of the individual components of attitude. As alluded to by Stanley and Benbow, in order to gain an accurate understanding of the relationship between attitude and achievement in mathematics, the various aspects of attitude should be taken into account. The studies cited also indicate that when considering the impact of attitude on the learning of mathematics it should not be assumed that it will be the same for all students.

Large–Scale Assessment Studies

Data from three major assessments, each involving thousands of students, has also been analyzed to determine the relationship between attitudes and achievement in mathematics. This research differs from the works mentioned previously, not only in terms of the numbers of subjects involved, but also in that these subjects were selected from broad geographical regions. The findings of the studies based on these assessments are discussed below.

National Assessment of Educational Progress

A study involving high school students was conducted by Horn and Walberg (1984) using the data collected in 1977-78 by the second National Assessment of Educational Progress (NAEP) in the United States. Representative communities from throughout the country were selected. Within each community, schools were chosen and then within the schools a random sample of age-specific students was selected. Using the data from the study of 17-year-old students, Horn and Walberg worked with a sample of 1480 cases. Although attitudes were not investigated directly, the relationship between interest in mathematics and achievement was analyzed.

For the purpose of the study, interest was a composite variable determined by the responses of the students to the following items: "How often did you work ahead in your mathematics book?"; "How often did you do mathematics problems that were not assigned?"; and "How often did you study mathematics topics that were not in the textbook?". Horn and Walberg reported a correlation value of 0.04 between interest and achievement and thus failed to find a link between the two variables.

Over 2000 thirteen-year-old students who participated in the same NAEP study were investigated by Tsai and Walberg (1983). An achievement test consisting of 74 items was used along with an attitude scale of 14 items. Analysis of variance was used to investigate the relationship between attitude and achievement. It was determined that attitude was associated with significant differences in achievement and that achievement was also associated with significant differences in attitude.

Further statistical analysis indicated that seven factors (sex, ethnicity, father's education, mother's education, home environment, experience, and attitude) accounted for 32 percent of the variance in achievement and this value was significant at the 0.001 level. Attitude was the factor with the second strongest link to achievement. Ethnicity had the greatest link. However, although achievement was determined to be significantly associated with attitude, only eight percent of the variance in attitude could be accounted for by a combination of seven factors, one of which was achievement, and this amount of variance was insignificant at the 0.05 level. These findings, which indicate that attitude may influence achievement but that achievement may not have an effect on attitude, coincide with the work of Newman who, likewise, did not find a causal relationship linking achievement to attitude.

Second International Mathematics Study

During the 1980-81 and 1981-82 school years, students from 20 education systems from around the world took part in the Second International Mathematics Study. Two populations of students, aged approximately 13 and 17, were sampled. A variety of data in both the attitude and achievement domains was collected.

Hong Kong was one of the countries which participated and Cheung (1988) examined the data for the 5644 Grade 7 students who participated in that region. Five-point Likert scales were used to determine student views on 10 attitudinal dimensions.

Moderate correlations with achievement were reported for the dimensions Mathematics-Myself (SELF), Mathematics and Society (SOC), and Mathematics-Create (CREATE). Of the achievement variance, 22.6 percent was associated with these three items treated as a single component. Of all the attitude dimensions, the SELF component, which is students' assessment of their own ability to do mathematics and is similar to the self-concept dimension discussed previously, had the greatest correlation with achievement.

Another aspect of this study concerned the reciprocal relationship between the attitude variables mentioned above and mathematics achievement. The unique contributions of achievement on SELF, SOC and CREATE were 0.047, 0.026 and 0.008 respectively. When combined with two of these three attitude components, achievement was found to explain between 24 percent and 35 percent of the variance in the remaining third component. Based on these findings, Cheung claimed that "the commonality analyses results ... made clear that the relationship of mathematics achievement and attitudes towards mathematics learning is reciprocal in nature" (p.218-219). However, the amount of the contribution of achievement on SELF, SOC and CREATE as reported by Cheung is low and does not appear to support his claim.

In a report on the attitudes of students from all of the jurisdictions involved in the same study, Kifer and Robitaille (1989) found large differences in the perception of mathematics by students of different countries. Kifer and Robitaille hypothesized that these variations may be due to such factors as differing curricula and educational philosophies. Another suggested hypothesis was that social factors may also have an effect on student attitudes. If this latter view is indeed correct, then the relationship between attitudes and mathematics performance may also be dependent upon the cultural context within which the students function.

British Columbia Mathematics Assessment

In 1985, the third British Columbia Mathematics Assessment, involving most students in Grades 4, 7, and 10 in the province, took place. The assessment included items on achievement, background, and attitude. The achievement section contained 150 items for each grade. Attitude was assessed using three scales with a total of 35 items covering the areas of mathematics in school, gender, calculators, and computers. Approximately 95,000 students took part in the assessment.

Taylor and Robitaille (1987) conducted a study of this data in part to examine the effect of students' opinions about mathematics on student achievement in this subject. The students were questioned on their opinions about the importance of mathematics, the difficulty in learning mathematics, and the enjoyment in learning mathematics. For students in Grades 4 and 7, the correlation with achievement for each of these items was weak and ranged in value from 0.09 to 0.27. At the Grade 10 level, moderate correlations of 0.42 and 0.45 were found between achievement and importance and achievement and difficulty respectively.

A regression analysis of student opinions and their relationship to achievement determined that, at the Grade 4 level, student opinions, with a beta weight of 0.19, had a limited effect on achievement. Student background, problem solving processes, and classroom organization were found to be more influential. For Grade 7 students, student opinions had a beta weight of 0.23 and had the greatest effect of all factors studied on change in achievement. In Grade 10, student opinion had a beta weight of 0.27 but the greatest predictor of change at this level was student background with a beta weight of 0.49.

In 1987, a replication study of the 1985 British Columbia Assessment was conducted. Pre-test and post-test information was gathered and used to do a comparison of cross-sectional and longitudinal models. When student entry-level factors were controlled in the longitudinal study, student opinion variables were considerably weaker predictors of achievement. However, the relative effects of the different variables such as opinions, classroom processes and background were the same as for the cross-sectional model. Taylor and Robitaille cautioned that "findings, based on student background and opinions of mathematics, should not be attributed solely to current classroom practices" (1987: p. 55).

The Use of Interviews

In each of the research studies mentioned previously, the instrument used to assess attitude was a self-reporting scale in which the subjects involved in the study responded directly to a questionnaire. Recent doctoral studies by Bassarear (1987) and Lucock (1989) have involved the use of interviews, essays, and observations in studies of attitudes and achievement in mathematics. The findings of these works are consistent with the results of most of the previous research. In a three-year longitudinal study which collected data through the use of a self-reporting scale and interviews, Lucock concluded that attitudes do affect mathematics performance. Similar results were found by Bassarear. In a study of ability, performance, and attitude of 16 students in a college remedial class, data regarding attitudes was collected through the use of questionnaires, essays, and interviews. It was found that "... several attitudes significantly added to the amount of variance explained in the exam average by the measures of ability" (1987: p. 2492-A).

Geometry and Data Analysis

Although it was noted by Aiken in 1970 that there was a need for research into attitudes towards specific mathematical topics, little work has been done in this area. In general, researchers have concentrated on segmenting attitude into its various components or on investigating the specific characteristics of students. Individual sections of the curriculum have not received the same attention.

Hogan (1977) made reference to this deficiency in his report on student interest in a variety of mathematical topics. Approximately 13,000 students from 10 states, who were enrolled in Grades 1 through 8, participated in a survey of student likes and dislikes regarding a list of mathematics items. A descriptive analysis of the findings was presented which indicated that, in general, as students progressed from Grades 1 through 8 their attitudes towards mathematics became less favourable. This situation, however, was not the same for all topics. Interest in computation remained fairly stable while the greatest decline in interest was in geometry.

However, the descriptive analysis of the data from the Second International Mathematics Study presented by Kifer and Robitaille (1989) presented a different view. When students at the Grade 8 level were asked to rate different parts of the mathematics curriculum using the following scales - important-unimportant, easy-difficult and like-dislike - the three geometry topics listed did not rank as being the least favoured ones. Depending upon the specific geometry topic, it was liked by approximately 40 percent to 60 percent of the respondents and considered important by 50 percent to 65 percent of the students. While research has been done which focuses on attitude towards some areas of mathematics such as problem solving and calculator use, there do not appear to have been any further studies linking attitude to achievement in geometry or data analysis.

Summary

The results of early studies into the relationship between attitudes and mathematics achievement were inconsistent. This research was limited in that the measurement instruments and the statistical methodology used needed improvement. Since the mid-1970's, the relationship between attitude and achievement has generally been seen to be an intricate one, involving many different dimensions. Recent studies have focused on specific aspects of attitudes and on certain attributes of the subjects. In general, the research has indicated that there is a significant relationship between some of the components of attitude and mathematics performance and that this relationship varies depending upon the grade and ability level of the students.

The gender of the student, the particular mathematical topic under study, and the culture within which the student lives have also been suggested as additional factors to be considered when investigating the connection between attitude and achievement. While there has been considerable research into the relationship between attitudes and gender, there has been little work done regarding the attitudes of students towards specific topics within the mathematics curriculum or the impact of culture on these attitudes. Although there is evidence that students have different attitudes towards different mathematics topics, it is not yet known if attitude has different links to achievement depending upon the particular curriculum domain under consideration. It has not been determined if the mathematical topic under consideration is a significant factor in the relationship between attitudes and mathematics achievement.

CHAPTER 3

METHOD

The purpose of this study was to investigate the relationship between student attitudes towards geometry and data analysis and student achievement in those domains of the mathematics curriculum. In order to examine this relationship, data from the 1990 British Columbia Mathematics Assessment was used. A description of the pertinent assessment materials and their development are found in this chapter. The details of sample selection and data analysis are also explained.

The 1990 British Columbia Mathematics Assessment

Participants in the Assessment

Most students in Grades 4, 7, and 10, who were enrolled in public and independent schools in British Columbia, were expected to take part in the 1990 Mathematics Assessment. Grades 4, 7, and 10 were selected because these grades represent critical junctures in the school system in that province. By Grade 4, students have completed their primary schooling and have the ability to participate in such a study. Grade 7 is the last year of elementary school and, as schooling in British Columbia is compulsory only to age 16, Grade 10 is the last year that most students are legally required to attend school. Both French and English versions of the assessment materials were available for use and the only students not expected to participate were those with moderate to severe mental handicaps.

As province-wide student enrollment figures were not available for the actual dates of the assessment and, as school enrollment fluctuates throughout the year, it is not possible to determine precise rates of participation by students in the assessment. However, as enrollment numbers are available for September 1989, it is possible to estimate these rates. Approximately 40,000 Grade 4 students and 37,000 Grade 7 students took part in the assessment. Based on the enrollment numbers for September, 1989, these figures indicate that there was almost full participation by students in these two grades. In Grade 10, the participation rate was lower with about 31,000 students, or approximately 84 percent of the Grade 10 student population as defined in September, 1989, taking part. This lower rate may have been due to students withdrawing from school during the year or to a higher absentee rate among students at the high school level than at the elementary school level. Some students of weaker mathematical ability may even have been discouraged from taking part in the study by their teachers.

Teachers of mathematics at Grades 4, 7, and 10 were also requested to participate in the assessment. Different teacher questionnaires were designed for each grade level and, for each of these grades, multiple versions of the questionnaire were developed. However, teachers were required to complete only one questionnaire, even if they taught more than one mathematics class. The numbers of forms completed by teachers were 1980 for Grade 4, 1692 for Grade 7, and 912 for Grade 10.

Structure of the Assessment Materials

The 1990 Mathematics Assessment collected data from both students and teachers. Students provided information on their personal backgrounds, on their attitudes toward mathematics, and on their perceptions of classroom practices. They also completed an achievement test. Teachers reported on their background characterisics, the implementation of the new mathematics curriculum, their classroom practices, their attitudes towards mathematics, and the content of the mathematics course which they were teaching.

All students and teachers completed forms consisting entirely of multiple-choice items. Information on students' ability to solve problems was obtained through the additional use of open-ended forms which were distributed to an eight percent random sample of students. For each grade level, four multiple-choice student forms, called Form A, Form B, Form C, and Form D, were randomly distributed within each classroom.

These four forms were each divided into two sections entitled Background Information and Achievement Survey, respectively. In the Grade 7 forms, the first seven of the 14 background items dealt with personal information and student perceptions of mathematics in general. These items were the same on all four forms. The remaining questions consisted of items concerned with student views on specific mathematics topics and items relating to student perceptions of classroom practices. This latter section was not the same on all forms although there were some individual items which were identical on two or more forms. The background section of the Grade 10 booklets, which contained 17 items, was structured in a similar manner. There were eleven items common to all four booklets. The last six items, dealing with individual mathematics topics and classroom practices, were not the same on all forms.

In the Achievement Survey section of the assessment, all students were asked 40 questions. The content of this section was not the same on all forms but it was intended that the forms be "... parallel by content weighting, cognitive behavior level, and difficulty at each grade" (Taylor & Robitaille, in press). An analysis of the psychometric properties of the forms confirmed that the forms were parallel. For any one grade, the mean score for each of the forms never differed by more than two percent and the standard deviations about the mean indicated the scores had similar variance on each form. The values of the reliability coefficients, which had a maximum range of 0.04 for any one grade, also indicated that the forms were consistent and stable as measures of student achievement. A detailed list of the statistical properties of the assessment booklets is given in Table 1 on the following page.

Table 1

Statistical Properties of the Assessment Booklets

	Mean	Standard Deviation	Reliability (KR 20)
Grade 4			
Form A	20.2	7.1	0.85
Form B	20.6	7.6	0.86
Form C	20.1	7.4	0.87
Form D	20.6	7.1	0.84
Grade 7			
Form A	21.7	7.1	0.85
Form B	20.5	7.2	0.85
Form C	21.6	7.8	0.87
Form D	21.3	7.5	0.86
Mathematics 10			
Form A	21.6	7.8	0.87
Form B	20.5	7.9	0.87
Form C	21.6	7.5	0.87
Form D	20.3	7.6	0.87
Mathematics 10A			
Form A	13.7	5.6	0.76
Form B	13.4	5.9	0.79
Form C	14.8	5.8	0.78
Form D	14.5	5.9	0.80

The achievement portion of the Grade 10 booklet was organized in a manner different from the Grades 4 and 7 booklets. In British Columbia, students have an option of enrolling in Mathematics 10 or Mathematics 10A. Mathematics 10 is the prerequisite to Mathematics 11 which is a course required for university entrance in that province. Completion of Mathematics 10A, however, does not entitle a student to enroll in Mathematics 11. Students may enroll in Mathematics 11A or they may complete an intermediate course, Introductory Mathematics 11, and then enroll in Mathematics 11. The course outlines for Mathematics 10 and Mathematics 10A have approximately 30 percent of their content in common. Thus, the achievement sections of the Grade 10 booklets were divided into three parts. Part 1 consisted of 20 items which were to be answered by all students and it contained items which were common to the curriculums of Mathematics 10 and Mathematics 10A. The 20 items in Part 2 were to be answered only by students enrolled in Mathematics 10A and the Mathematics 10 students answered the 20 items in Part 3.

Different versions of the teacher questionnaire were also developed. There were three forms for Grade 4, three for Grade 7 and two for Grade 10. The questionnaires were divided into five sections. The Background Information and Implementation Information sections were common to all versions whereas the Classroom Practices, Mathematics in School and Opportunity to Learn sections were not the same on all forms. Full details of all of the forms are available in the Technical Report of the assessment (Robitaille, in press).

All students were allocated one hour of time for the assessment. A pilot study had indicated that one hour should provide enough time for almost all students to answer the questions in their booklets. There was no limitation on the amount of time used for completion of the teacher questionnaires.

Content of the Assessment Materials

The initial development of the items for the assessment forms was the responsibility of the Contract Team which consisted of individuals from throughout the mathematics education community in British Columbia. The work of the Contract Team was reviewed by the Advisory Committee and the Review Panel whose members had been selected so as to provide a cross-section of opinions regarding the learning of mathematics. The Advisory Committee advised the Contract Team and reviewed all items before they were presented to the Review Panel. The Review Panel then considered each of the items in the context of the original objectives of the assessment . This development process was established so as to ensure the content validity of the assessment instruments.

The achievement component of the Mathematics Assessment student forms was intended to reflect the content of the British Columbia mathematics curriculum for students from Grades 1 through 10. The achievement items on the Grade 4 forms were based on the mathematics curriculum for Grades 1 through 4, the Grade 7 items were based on the curriculum for Grades 5 through 7, and the Grade 10 items were based on the curriculum for Grades 8, 9 and 10.

The content of the achievement section was divided into six strands for Grades 4 and 7. These strands were whole numbers, rational numbers, data analysis, geometry, measurement and algebra. For Grade 10, the whole numbers and rational numbers strands were combined into one section called numbers and operations. The other four strands were the same as those used in Grades 4 and 7. This information is summarized in Table 2.

Table 2

Content Strands for Achievement Items

Grade 4	Grade 7	Grade 10
Whole Numbers	Whole Numbers	Numbers & Operations
Rational Numbers	Rational Numbers	
Algebra	Algebra	Algebra
Data Analysis	Data Analysis	Data Analysis
Geometry	Geometry	Geometry
Measurement	Measurement	Measurement

At each grade level, each of the strands listed above was divided into topics. These topics were then separated into three cognitive behaviour levels: computation, comprehension and application/problem solving. This structure was used as the basis for the development and selection of the achievement items to be used on the assessment.

Many of the individual achievement items were developed specifically for this assessment. The mathematics curriculum in British Columbia has recently undergone revision and the development of items was required for new topics which had been introduced into the curriculum. Other items were drawn from such sources as the 1985 Provincial Mathematics Assessment, the National Assessment of Educational Progress in the United States, and the Second International Mathematics Study.

As noted previously, all of the achievement questions followed a multiple-choice format. Students selected a response from a range of five possible options. The fifth option was always the statement "I don't know".

A pool of achievement items was developed and pilot tested in October, 1989. The Grade 4 material was administered to 46 Grade 5 classes, the Grade 7 material was given to 42 Grade 8 classes, and the Grade 10 items were administered to 43 Grade 11 classes. Questions where not all of the response options were selected, or where more than 95 percent or less than 10 percent of the students answered the item correctly, were either changed or not used in the assessment. Items where the point-biserial correlation between the correct answer and the total test score was less than 0.20 or less than the corresponding correlation between a distractor and the total test score were also altered or deleted.

Information about students' perceptions of specific mathematics topics was determined by asking participants to rate how important the topic was, how easy the topic was, and how much the topic was liked. The Grade 10 forms referred to nine topics and twelve topics were listed in the Grade 7 forms. Teachers were asked to rate the same topics by indicating how important the topic was for the class, how easy it was to teach the topic, and how much they liked teaching the topic.

Students and teachers responded to the above items on a five-point Likert scale with a range of options from "not at all important" to "very important", "very difficult" to "very easy" and "dislike a lot" to "like a lot". This scale had been adapted from one developed by the International Association for the Evaluation of Educational Achievement.

Sample Selection

The sample used in this study was selected from the data collected by the 1990 Mathematics Assessment. Authorization to use this data was obtained from the British Columbia Ministry of Education.

Description of the Sample

As the purpose of this study was to investigate students' attitudes towards geometry and data analysis, the participants in the sample consisted of all students enrolled in Mathematics 7, 10, or 10A who answered the background questions in the assessment forms relating to these concerns. While all forms contained items about students' perceptions of individual mathematics topics, not all forms asked students about geometry and data analysis. At the Grade 7 level, only students who received Form A were given the opportunity to state their views on these topics and in Grade 10 a similar opportunity was given to the recipients of Forms C or D.

Within every class which participated in the assessment, four different assessment forms were distributed randomly to the students. The sample size of 9491 cases selected at the Grade 7 level represents the number of students who received Form A and is approximately 25 percent of the total enrollment in that grade. As the forms were distributed randomly and there was almost a 100 percent participation rate for this grade, this sample is representative of the population of students enrolled in Grade 7 in British Columbia at that time.

One of the items asked students who received the Grade 10 forms which mathematics course they had been enrolled in during the 1989-1990 school year. A total of 14,786 of the students who responded to Forms C or D indicated that they had been enrolled in Mathematics 10 or 10A. Of these students, 10,907 had studied Mathematics 10 and 3879 had taken Mathematics 10A. The distribution of the participants by grade is summarized in Table 3.

Table 3

Distribution of Subjects by Course Enrollment

Course	Number of Subjects
Mathematics 7	9491
Mathematics 10	10907
Mathematics 10A	3879

The participation rate in the assessment at the Grade 10 level was approximately 84 percent. It is not certain if the 16 percent who did not participate represented a random selection of students or if they belonged to a particular sub-group of the population. As the Grade 10 forms were distributed randomly to the students, the sample cases are representative of the population of students enrolled in Grade 10 mathematics courses who participated in the assessment but they are not necessarily representative of all students who were enrolled in Grade 10 at the time of the assessment.

Data Collection Instruments

In order to assess students' perceptions of geometry and data analysis, student responses to the relevant Background Information items on the assessment forms were analyzed. The specific questions relating to geometry and data analysis which were asked of the Grade 10 students are displayed in Figure 1. The Grade 7 students' questions were similar in content, the only difference being that the headings "Geometry" and "Data analysis" were replaced with the titles "Learning geometry" and "Working with data and graphs".

For each of the next three items, three answers are needed
A) Tell how important you think the topic is.
B) Tell how easy you think the topic is.
C) Tell how much you like the topic.

If you are not sure what a topic means, leave its three answers blank.

Geometry

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

Data Analysis

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

Figure 1. Grade 10 background items: Geometry and data analysis.

Student achievement was evaluated based upon performance on the Achievement Survey portion of the assessment. Those items which corresponded directly to the geometry and data analysis strands of the mathematics curriculum were used to assess student performance in those areas. As Grade 7 Form A and Grade 10 Forms C and D were the only forms containing background items relating to geometry and data analysis, achievement assessment items were selected from those forms. A list of the item numbers used to evaluate achievement in geometry and data analysis at each grade level is given in Table 4. Table 4 also lists the intended learning outcome number from the mathematics curriculum to which each item corresponds. The content of the geometry and data analysis questions which were asked can be found in Appendix A.

Table 4

Strands and Item Assignments

Course	Strand	Form and Item Number	Intended Learning Outcome Number
Math 10	Geometry	C: 9, 10, 11*, 12 45, 46, 47, 48, 49, 50, 51, 52, 60	8.52, 8.48, 10A.24, 10A.24, 10.23, 10.26, 8.52, 9.15, 9.15 9.14, 10.19, 9.17, 8.54
		D: 9, 10, 11*, 12, 45, 46, 47, 48, 49, 50, 51, 52	9A.32, 8.51,10A.24, 10A.25, 9.25, 8.56, 8.51, 9.14, 10.17, 9A.37, 8.47, 10.20
	Data Analysis	C: 5*, 6, 7*, 8*, 43, 44*	10A.21, 10A.19, 9A.31, 9A.31, 8.38, 9.13
		D: 5*, 6, 7*, 8*, 43,44*	10A.21, 10A.14, 9A.31, 9A.31, 10A.19, 9.13
Math 10A	Geometry	C: 9, 10, 11*, 12, 33*, 34, 35, 36	8.52, 8.48, 10A.24, 10A.24, 9A.37,10A.29,10A.27,10A.32
		D: 9, 10, 11*, 12, 33*, 34, 35, 36	9A.32, 8.51, 10A.24, 10A.25, 9A.37,10A.26,10A.29, 10A.32
	Data Analysis	C: 5*, 6, 7*, 8*, 30, 31, 32	10A.21, 10A.19, 9A.31, 9A.31 10A.19, 9A.24, 8.37
		D: 5*, 6, 7*, 8*, 30, 31, 32	10A.21, 10A.14, 9A.31, 9A.31 8.40, 9A.24, 9A.24
Math 7	Geometry	A: 25, 26, 27, 28, 29, 30	7G33, 7G33, 7G5, 7G23, 7G3, 7G47
	Data Analysis	A: 19, 21, 22, 23, 24	7D13, 7D12, 7D1, 7D12, 7D1

*items common to both forms

Data Analysis

The mathematics assessment materials were sent to the British Columbia Ministry of Education for marking and coding. All responses to the background and achievement items were coded. Responses to achievement items were also recorded as being either correct or incorrect. Items to which there was no response were coded as blanks. The resulting data file was used as the basis of the analysis for this study.

Coding of Sample Materials

The items in the assessment which related to student perceptions of individual mathematics topics requested that students indicate their views on how important the topic was, how easy the topic was, and how much the topic was liked. For the purposes of this study, these three dimensions were considered to be separate components of attitude and the data for each area analyzed independently.

As indicated in Figure 1, there were five possible responses which students could make when answering the questions relating to geometry and data analysis. When the data were coded for this study, these five options were replaced with just two categories. Student responses were recoded to indicate if the topic was important or not important, easy or difficult, or if it was liked or disliked. For example, responses which indicated that geometry was "not at all important" or "not important" were all coded under the heading "not important" while those characterizing it as being "important" or "very important" were grouped together under the heading "important". All "undecided" responses were ignored. Similar coding was used to classify the "easy" and "like" dimensions of attitude.

All responses to the achievement items were coded as being correct or incorrect. If the question was not answered, it was considered to have been answered incorrectly. Achievement in geometry and data analysis was determined by calculating the percent of the responses which were correct in each of these strands. These results for each strand were then divided into five groups. The range of scores in each group is listed in Table 5.

Table 5

Classification of Achievement Scores

Group	n = achievement in percent
1	$0\% < n \leq 20\%$
2	$20\% < n \leq 40\%$
3	$40\% < n \leq 60\%$
4	$60\% < n \leq 80\%$
5	$80\% < n \leq 100\%$

Chi-Square Analysis

The relationship between student attitudes towards geometry and data analysis and achievement in those areas was investigated through the use of chi-square analysis. In order to conduct this investigation, matrices which linked attitude and achievement were developed. The scale on the vertical axis of these matrices consisted of one of the following pairs of values: important/not important, easy/difficult, or like/dislike. The horizontal scale consisted of the five achievement groupings. Thus, six 2 X 5 matrices were developed, one for each of the three attitude dimensions associated with geometry and data analysis. The statistical program SPSS/PC+, Version 3.1, was used to construct these matrices and calculate the chi-square value. The results were then analyzed.

The relationship between overall mathematical ability and attitude was also studied through the use of this procedure. Mathematical ability was determined by the results on the entire achievement part of the forms. In order to investigate the relationship among attitudes, achievement and the grade of the student, data from both Grades 7 and 10 was analyzed. Students in Grade 10 were also classified according to which Grade 10 mathematics course they had taken. This collection of data was then examined to determine if there was an association among streaming, attitudes and achievement.

As approximately 16 percent of the Grade 10 student population in British Columbia did not participate in the mathematics assessment, the Grade 10 data were investigated further in order to study the possible impact of this situation. It is not known if the non-participants were a representative sample of the entire student population or if they represented a particular sub-group. Individual cells in the matrices were adjusted to reflect this latter "worst-case" scenario and the chi-square value was then calculated. These results were then analyzed.

Summary

This chapter has described the 1990 British Columbia Assessment materials from which the sample data for this study was drawn. The sampling procedure and the methods of data analysis were also discussed. The results of the study are reported in the next chapter. In the final chapter, the conclusions based on these findings and the implications of the results are presented.

CHAPTER 4

FINDINGS

Discussed in this chapter are the findings of the study. A description of the variables is given as well as the results of the chi-square analysis of the Grade 10 data for each of the components of attitude which were investigated. Possible effects of overall achievement in mathematics, grade level, and streaming are also explored. The chapter concludes with a discussion of the impact on the research of the absence of 16% of the Grade 10 students from participation in the study.

Description of the Variables

Two variables relating to the learning of mathematics were investigated in this study. These were attitude and achievement. The relationship between these variables within the domains of geometry and data analysis was the central focus of the research.

Student Attitudes

As indicated in the previous chapter, the 1990 British Columbia Mathematics Assessment requested that students indicate their views regarding certain topics in mathematics. Students were asked to respond in three separate categories. They were to state how important the topic was, how easy the topic was, and how much the topic was liked. For the purpose of this study, these three dimensions of attitude were analyzed independently of each other. Attitude was not defined as a single variable. Therefore, the statistical analysis of students' attitudes involved working with the data regarding their views on the importance, difficulty, and likeability of geometry and data analysis.

Students in Grade 7 who received Form A were asked about their perceptions of geometry and data analysis. The number of students who completed this form was 9491. Forms C and D were the Grade 10 assessment materials which contained questions regarding geometry and data analysis and 15,602 of these forms were completed. Only those students who indicated that they were enrolled in Mathematics 10 or Mathematics 10A were included in the sample.

Not all students who received these forms responded to every question. Students who did not respond to a question were not included in the statistical analysis for that particular item but their responses to other items were included in other analyses. Similarly, students who selected the "undecided" option when responding to an attitude item were also omitted from the sample. For each item, the remaining responses were then grouped into two categories. The topics were consided to be important or not important, easy or difficult, and liked or disliked. The level of response to each of the attitude items is listed below in Table 1.

Table 1

Student Responses to Attitude Items

	forms completed	item answered	"undecided" option selected	sample size
Grade 7	9491			
Geometry: importance		9315	1759	7556
Geometry: difficulty		9206	1812	7394
Geometry: likeability		9215	1735	7480
Data Analysis: importance		9235	1886	7349
Data Analysis: difficulty		9131	2268	6863
Data Analysis: likeability		9099	2187	6912
Mathematics 10 & 10A	14786			
Geometry: importance		14502	3824	10678
Geometry: difficulty		14443	2890	11553
Geometry: likeability		14461	3149	11312
Data Analysis: importance		13718	5018	8700
Data Analysis: difficulty		13667	6821	6846
Data Analysis: likeability		13657	7059	6598

In Grade 10, the response rate for the data analysis items was lower than for the geometry items. This difference may have been due to the fact that, as reported in the technical report on the mathematics assessment (Robitaille, in press), at the time of the assessment a large number of teachers of Grade 10 mathematics had not yet taught the material in the data analysis strand to their students. Students may not have been familiar enough with the material to enable them to respond. Also, some students may not have been certain as to what was meant by the phrase "data analysis". The data analysis strand has been introduced recently into the British Columbia mathematics curriculum. Teachers and students may not have put the term "data analysis" into frequent use. These reasons may also explain why a large number of the students chose the "undecided" option when responding to the data analysis items.

On the Grade 7 form, the question on data analysis was worded differently than on the Grade 10 forms and it gave more information as to the content of the material in question. The Grade 7 students were asked for there perceptions on "working with data and graphs". This difference may partially explain why their was a higher response rate to the data analysis questions at the Grade 7 level than at the Grade 10 level.

Student Achievement

In this study, student achievement values were calculated for both the geometry and data analysis strands and for the entire achievement portion of the assessment. Student achievement in geometry and data analysis was determined by the number of items which were correct in each of these domains of the assessment. Blank responses to an item were considered to be incorrect. The total number correct was then converted to a percent. The percents were then divided into five groups each with a range of 20%. Table 5 in Chapter 4 summarizes the percentage values assigned to each of these groups.

A list of the individual items which were used to assess achievement in data analysis and geometry can be found in Table 4 of Chapter 3. Listed in Table 2 below is the number of items which were used to determine achievement in each domain. As indicated in the table, the number of items in the geometry and data analysis strands was not the same for Mathematics 10 as for Mathematics 10A. This situation reflects the fact that there is a different emphasis placed on data analysis and geometry in the curriculums of each of these courses.

Table 2

Number of Items Used to Assess Achievement

		Data Analysis	Geometry
Mathematics 7:	Form A	5	6
Mathematics 10:	Form C	6	13
	Form D	6	12
Mathematics 10A:	Form C	7	8
	Form D	7	8

The same procedure was used to calculate overall student achievement in mathematics. All students were asked 40 questions in the achievement portion of the assessment. The score, which was determined by the number of items answered correctly, was then converted to a percent.

Data Analysis and Geometry

As reported earlier, the items which were used to assess achievement in the areas of data analysis and geometry were selected from the achievement section of the 1990 British Columbia Mathematics Assessment. These items were selected for inclusion in the assessment based upon their correspondence to the items in the mathematics curriculum guide of the province of British Columbia. Thus, for the purposes of this study, the definitions of the terms data analysis and geometry correspond to the definitions implied in the use of these terms in the British Columbia mathematics curriculum guides for Grade 7 and Grade 10.

Grade 10–Geometry and Data Analysis

The analysis of the data involved the use of chi-square to determine if there was a significant relationship between achievement in mathematics and attitudes toward certain mathematical topics. These analyses were concerned with three different components of attitude and were performed on data from two grade levels. Presented below is a discussion of the findings concerning the Grade 10 geometry and data analysis material.

Grade 10–Geometry

The analysis of the Grade 10 data was organized in the following manner. For each of the three dimensions of attitude–importance, difficulty, and likeability–a 2 X 5 matrix was designed. One axis of each matrix represented attitude and its scale was divided into two parts: not important/important, difficult/easy, or dislike/like. The other axis represented achievement in the geometry domain and its scale ranged in value from one to five. These values corresponded to the five groupings which had been established for the achievement scores. A chi-square analysis was then performed on each of these matrices. The results of the analyses of the geometry data are given in Tables 3, 4, and 5 on the following pages.

As the chi-square values for all three matrices were significant at 0.0000, it can be concluded that each of the three components of attitude towards geometry is related to achievement in geometry. However, given the large sample sizes involved in this study, these results do not necessarily indicate that a strong relationship exists.

Of more interest are the trends that are revealed in the individual cells of the matrices. All three matrices indicate that a student who does well is more likely to consider geometry to be important, easy, and likeable than one who does poorly. In all three areas, the percentage of students who responded positively towards geometry rose steadily as the achievement levels increased. This situation is reflected in the relationship between the

Table 3

Grade 10: Chi-Square Analysis
Importance of Geometry and Achievement in Geometry

Importance		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Not Important	6.4%	11.5%	8.9%	6.5%	2.0%	35.3%
	Expected Value	4.7%	9.9%	9.1%	8.1%	3.6%	
	Important	6.9%	16.5%	16.8%	16.4%	8.1%	64.7%
	Expected Value	8.6%	18.1%	16.6%	14.8%	6.5%	
	Total	13.3%	28.0%	25.7%	22.9%	10.1%	N=10678 100%

Chi-square = 309.9; D.F. = 4; significance level = 0.0000

Table 4

Grade 10: Chi-Square Analysis
Difficulty of Geometry and Achievement in Geometry

Difficulty		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Difficult	7.8%	14.0%	9.7%	6.0%	1.7%	39.2%
	Expected Value	5.3%	10.9%	10.0%	9.0%	4.0%	
	Easy	5.7%	13.8%	15.9%	17.0%	8.5%	60.8%
	Expected Value	8.2%	16.9%	15.6%	14.0%	6.2%	
	Total	13.5%	27.8%	25.6%	23.0%	10.1%	N=11553 100%

Chi-square = 832.0; D.F. = 4; significance level = 0.0000

Table 5

Grade 10: Chi-Square Analysis
Likeability of Geometry and Achievement in Geometry

Likeability		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Dislike	8.9%	15.8%	11.3%	7.6%	2.4%	46.0%
	Expected Value	6.3%	12.9%	11.7%	10.5%	4.5%	
	Like	5.0%	12.2%	14.2%	15.3%	7.3%	54.0%
	Expected Value	7.5%	15.2%	13.8%	12.3%	5.3%	
	Total	13.8%	28.1%	25.5%	22.9%	9.8%	N=11312 100%

Chi-square = 719.3; D.F. = 4; significance level = 0.0000

actual numbers in each of the cells as compared to the expected values for each cell. In the cells which indicated a negative attitude towards geometry, the number of students achieving a score of less than or equal to 40% was greater than the expected value and the number achieving greater than 40% was less than the expected value. The reverse situation occurred with students who had a positive attitude towards geometry. Fewer students than the expected value did poorly and the number of students who achieved greater than 40% was greater than the expected value.

Having a positive attitude towards geometry did not necessarily mean that a student obtained good results in the geometry portion of the assessment. For example, 65% of the students indicated that geometry was important. Of these students, only 33% had a result of more than 60% on the geometry achievement section. However, those students who had a positive attitude did tend to achieve better results than those who had the opposite view. For example, only 24% of the students who stated that geometry was not important achieved more than 60% on this section whereas 38% of those who thought it was important obtained a score greater than 60%.

Fewer students thought geometry was easy than those who considered it to be important, and even fewer still liked the topic. Only 54% of the students indicated that they liked geometry whereas 61% stated that it was easy and 65% considered it to be important. While a majority of the students who did poorly found geometry to be difficult and disliked it, more than half of the students who did poorly considered geometry to be important. At all five achievement levels, more students considered geometry to be important than considered it to be not important.

Grade 10–Data Analysis

The same method of analysis that was applied to the geometry strand was used to investigate the data analysis strand. Students' attitudes towards the importance, difficulty, and likeability of data analysis were examined to determine how they related to achievement in this area. The results of this analysis are given in Tables 6, 7, and 8 on the following pages.

Similar results were found for the data analysis strand as were found for the geometry strand. The chi-square values were significant at the 0.0000 level in all three cases which suggests that achievement in data analysis is related to each of the components of attitude examined in the matrices. The number of students who achieved poor results and who also considered data analysis to be unimportant or difficult, or who disliked it exceeded the expected value for those cells. The number of students who did well and who had negative views towards data analysis was less than the expected value. Conversely, less than the expected number of students with positive attitudes towards data analysis did poorly and more than the expected value did well.

Table 6

Grade 10: Chi-Square Analysis
Importance of Data Analysis and Achievement in Data Analysis

Importance		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Not Important	3.9%	4.3%	5.0%	2.3%	1.5%	17.0%
	Expected Value	2.5%	3.5%	5.2%	3.5%	2.4%	
	Important	10.6%	16.0%	25.5%	18.2%	12.7%	83.0%
	Expected Value	12.0%	16.9%	2.5%	17.0%	11.7%	
	Total	14.5%	20.3%	30.5%	20.5%	14.1%	N=8700 100%

Chi-square = 191.4; D.F. = 4; significance level = 0.0000

Table 7

Grade 10: Chi-Square Analysis
Difficulty of Data Analysis and Achievement in Data Analysis

Difficulty		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Difficult	8.3%	9.0%	11.9%	6.1%	3.0%	38.3%
	Expected Value	5.9%	7.4%	11.7%	7.7%	5.5%	
	Easy	7.2%	10.3%	18.7%	14.1%	11.4%	61.7%
	Expected Value	9.6%	11.9%	18.9%	12.5%	8.9%	
	Total	15.5%	19.3%	30.6%	20.2%	14.4%	N=6846 100%

Chi-square = 305.5; D.F. = 4; significance level = 0.0000

Table 8

Grade 10: Chi-Square Analysis
Likeability of Data Analysis and Achievement in Data Analysis

		Achievement (percent)					
		0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
Likeability	Dislike	9.1%	9.9%	13.5%	7.4%	4.9%	44.8%
	Expected Value	7.1%	8.8%	13.9%	8.8%	6.3%	
	Like	6.7%	9.7%	17.4%	12.2%	9.1%	55.2%
	Expected Value	8.7%	10.8%	17.0%	10.8%	7.7%	
	Total	15.8%	19.7%	30.9%	19.6%	14.0%	N=6598 100%

Chi-square = 148.1; D.F. = 4; significance level = 0.0000

The percentage of students who liked data analysis or considered it to be easy was within one percentage point of the percentage of students who indicated those views about geometry. Likewise, the distribution of the percentages of students who held these views over the five achievement levels was similar for both curriculum domains.

However, more students indicated that data analysis was important than stated that geometry was important. Approximately 65% of the students responded that geometry was important whereas 83% stated that data analysis was important. This high rate of favourable responses may explain why the gap between the expected value and the actual value of the number of students who considered data analysis to be important and who achieved high scores was only 0.9%. However, the difference between expected value and actual value for low achievers who considered data analysis to be unimportant (37%) matched the patterns found for the other data.

Overall Achievement in Mathematics

In order to gain an understanding of the relationship between students' overall mathematical achievement and their attitudes towards specific topics in the mathematics curriculum, the Grade 10 assessment data were explored further. The results of this work with geometry and data analysis are given below.

Overall Achievement and Geometry

Three matrices, similar to those used to study achievement in geometry, were designed to investigate the relationship between overall achievement in mathematics and attitudes towards geometry. The findings concerning these data are given in Tables 9, 10, and 11 below.

Table 9

Grade 10: Chi-Square Analysis
Importance of Geometry and Overall Achievement in Mathematics

		Achievement (percent)					
		0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
Importance	Not Important	3.2%	13.5%	12.0%	5.5%	1.0%	35.3%
	Expected Value	2.3%	11.2%	12.5%	7.3%	2.0%	
	Important	3.4%	18.2%	23.4%	15.2%	4.6%	64.7%
	Expected Value	4.3%	20.5%	22.9%	13.4%	3.7%	
	Total	6.6%	31.7%	35.4%	20.7%	5.6%	N=10678 100%

Chi-square = 289.7; D.F. = 4; significance level = 0.0000

Table 10

Grade 10: Chi-Square Analysis
Difficulty of Geometry and Overall Achievement in Mathematics

Difficulty		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Difficult	4.1%	16.0%	13.5%	4.7%	0.8%	39.2%
	Expected Value	2.6%	12.5%	13.8%	8.1%	2.3%	
	Easy	2.5%	15.8%	21.6%	16.0%	5.0%	60.8%
	Expected Value	4.0%	19.3%	21.3%	12.6%	3.5%	
	Total	6.6%	31.8%	35.1%	20.7%	5.8%	N=11553 100%

Chi-square = 806.5; D.F. = 4; significance level = 0.0000

Table 11

Grade 10: Chi-Square Analysis
Likeability of Geometry and Overall Achievement in Mathematics

Likeability		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Dislike	4.5%	18.3%	15.3%	6.5%	1.2%	46.0%
	Expected Value	3.1%	15.0%	15.9%	9.5%	2.5%	
	Like	2.1%	14.3%	19.3%	14.2%	4.1%	54.0%
	Expected Value	3.6%	17.6%	18.7%	11.2%	2.9%	
	Total	6.7%	32.7%	34.6%	20.7%	5.3%	N=11312 100%

Chi-square = 631.1; D.F. = 4; significance level = 0.0000

As was the case with achievement in geometry, the chi-square values for the matrices dealing with the relationship between achievement in mathematics and attitudes towards geometry were significant at the 0.0000 level. These findings suggests that there is a significant association between students' views as to the importance, difficulty, and likeability of geometry and their overall performance in mathematics.

However, the proportion of students scoring in each of the five achievement categories was not the same for both achievement in geometry and achievement in mathematics. The distribution of geometry scores was more consistent across the five categories than the distribution of overall mathematics scores. In the geometry portion of the assessment, approximately 10% of the students scored higher than 80% and about 13% scored less than 20% whereas only 6% of the students achieved total assessment scores of above 80% and approximately 7% obtained scores of less than 20%. In general, students scored higher on the geometry portion of the assessment than they did on the overall assessment. Approximately 27% of the students obtained a score of 60% or better on the assessment whereas approximately 33% of the students achieved in this range of scores on the geometry unit.

In contrast, the percentage of students in each achievement category who considered geometry to be important, easy, or likeable was similar for performance both in geometry and in mathematics. A comparison of the matrices which examined performance in geometry with those which examined performance in mathematics reveals that the difference between the percentage of students at any one achievement level who considered geometry favourably was never more than 4%. In eleven out of fifteen cases, this difference was 2% or less. For example, geometry was liked by approximately 75% of the students who obtained high scores in this topic and it was also liked by about 77% of the students who scored well on the overall assessment. It was disliked by approximately 64% of the students who did poorly on the geometry unit and by approximately 68% of the students who obtained low scores on the assessment.

<u>Overall Achievement and Data Analysis</u>

The findings concerning overall achievement in mathematics and attitudes towards data analysis were determined in a manner similar to those regarding geometry. Three matrices were designed to examine these relationships. The results of this analysis can be found in Tables 12 through 14.

The chi-square values for each of these matrices were significant at the 0.0000 level. These results parallel the findings regarding attitudes towards data analysis and achievement in this domain and they suggest that achievement in mathematics and attitudes towards data analysis are related.

Table 12

Grade 10: Chi-Square Analysis
Importance of Data Analysis and Overall Achievement in Mathematics

Importance		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
Importance	Not Important	2.1%	7.2%	5.2%	2.0%	0.5%	17.0%
	Expected Value	1.0%	5.1%	6.0%	3.8%	1.1%	
	Important	4.0%	22.7%	29.9%	20.3%	6.1%	83.0%
	Expected Value	5.1%	24.8%	29.2%	18.5%	5.4%	
	Total	6.1%	29.9%	35.1%	22.3%	6.5%	N=8700 100%

Chi-square =352.9; D.F. = 4; significance level = 0.0000

Table 13

Grade 10: Chi-Square Analysis
Difficulty of Data Analysis and Overall Achievement in Mathematics

		Achievement (percent)					
		0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
Difficulty	Difficult	4.2%	15.1%	12.5%	5.6%	0.8%	38.3%
	Expected Value	2.6%	11.8%	12.8%	8.4%	2.6%	
	Easy	2.7%	15.8%	21.0%	16.3%	6.0%	61.7%
	Expected Value	3.3%	15.0%	16.3%	10.6%	3.3%	
	Total	4.3%	19.1%	20.7%	13.5%	4.2%	N=6846 100%

Chi-square = 451.9; D.F. = 4; signiicance level = 0.0000

Table 14

Grade 10: Chi-Square Analysis
Likeability of Data Analysis and Overall Achievement in Mathematics

		Achievement (percent)					
		0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
Likeability	Dislike	4.4%	16.8%	14.5%	7.1%	2.0%	44.8%
	Expected Value	3.2%	14.1%	15.3%	9.5%	2.7%	
	Like	2.7%	14.6%	19.6%	14.2%	4.1%	55.2%
	Expected Value	3.9%	17.3%	18.9%	11.8%	3.4%	
	Total	7.1%	31.3%	34.2%	21.2%	6.1%	N=6598 100%

Chi-square = 227.1; D.F. = 4; significance level = 0.0000

The data analysis results were similar to the geometry results in that the achievement scores for data analysis were more consistent across the five achievement levels than were the scores for the overall assessment. Approximately 14% of the students achieved more than 80% on the data analysis section of the assessment while only 7% of the students achieved in this range on the overall assessment. Likewise, 7% of the students scored below 20% on the assessment whereas 15% of the students had low scores on the data analysis unit. Also, more students scored 60% or higher on the data analysis unit than on the overall assessment. The percentage of students obtaining marks in this range was 35% and 29% respectively.

However, unlike the findings for geometry, the percentages of students at each achievement level who viewed data analysis favourably were not the same for the matrices which dealt with performance in mathematics as they were for the matrices which were concerned with performance only in the area of data analysis. For these two sets of matrices, the difference between the percentages of students who had positive attitudes towards data analysis was at times as high as 9%. For example, 53% of the students who obtained scores less than 20% on the data analysis unit considered data analysis to be difficult whereas 61% of the students who had low overall scores on the assessment held these views. Data analysis was considered easy by 79% of the students who scored well on the data analysis unit while 88% of the students who obtained high scores on the assessment considered data analysis easy.

Grade Levels–Grade 7 and Grade 10

The assessment materials for students in Grades 7 and 10 were examined in order to determine if the grade level of the student was a factor in the relationship between attitudes towards geometry and data analysis and achievement in those areas. The Grade 7 data was analyzed in the same manner as the Grade 10 data. For both geometry and data analysis, matrices which dealt with each of the three components of attitude were produced.

<u>Grade 7–Geometry</u>

The results of the work with the Grade 7 geometry data are reported in Tables 15 through 17 and the data analysis results are presented in the next section. Each of the tables given below illustrates the findings for the chi-square analysis of the relationship between achievement in geometry and a particular component of attitude.

The matrices which were concerned with how much students liked geometry or with how difficult they found it contained findings similar to the corresponding matrices for students in Grade 10. The chi-square values for each of these matrices were significant at

Table 15

Grade 7: Chi-Square Analysis
Importance of Geometry and Achievement in Geometry

		Achievement (percent)					
		0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
Importance	Not Important	2.1%	2.4%	3.2%	2.7%	1.7%	12.1%
	Expected Value	1.8%	2.4%	3.0%	2.7%	2.3%	
	Important	12.5%	17.3%	21.8%	19.4%	16.8%	87.9%
	Expected Value	12.8%	17.3%	22.0%	19.4%	16.3%	
	Total	14.6%	19.7%	25.0%	22.1%	18.6%	N=7556 100%

Chi-square = 17.8; D.F. = 4; significance level = 0.0013

Table 16

Grade 7: Chi-Square Analysis
Difficulty of Geometry and Achievement in Geometry

Difficulty		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Difficult	5.5%	6.3%	6.9%	4.4%	2.5%	25.6%
	Expected Value	3.6%	4.8%	6.5%	5.7%	4.9%	
	Easy	8.6%	12.7%	18.4%	17.9%	16.8%	74.4%
	Expected Value	10.5%	14.1%	18.8%	16.6%	14.4%	
	Total	14.1%	19.0%	25.3%	22.3%	19.3%	N=7394 100%

Chi-square = 297.4; D.F. = 4; significance level = 0.0000

Table 17

Grade 7: Chi-Square Analysis
Likeability of Geometry and Achievement in Geometry

Likeability		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Dislike	5.6%	6.6%	7.6%	6.1%	4.2%	30.1%
	Expected Value	4.4%	5.9%	7.5%	6.7%	5.6%	
	Like	9.2%	12.9%	17.2%	16.1%	14.5%	69.9%
	Expected Value	10.3%	13.6%	17.4%	15.5%	13.1%	
	Total	14.7%	19.5%	24.8%	22.2%	18.7%	N=7480 100%

Chi-square = 86.1; D.F. = 4; significance level = 0.0000

the 0.0000 level which suggests that, for students in Grade 7, there is a significant relationship between these two perceptions of geometry and achievement in geometry. As was the case for the Grade 10 students, the number of Grade 7 students who disliked geometry or found it difficult and who did poorly on the achievement section was greater than the expected value. Also, the number of students who liked geometry, or who found it easy, and who achieved good scores on the geometry unit was greater than the expected value.

The relationship between the Grade 7 students' views of the importance of geometry and their performance in geometry, however, was different than that for Grade 10 students. The chi-square value for the matrix dealing with this relationship had a significance level of 0.0013. In all five achievement categories in this matrix, a minimum of 85% of the students considered geometry to be important with approximately 88% of the total Grade 7 sample holding this view. There was only a 5 point difference between the percentage of students in the highest achievement category who considered geometry to be important and the percentage of students in the lowest category who indicated the same view. In contrast, 65% of the Grade 10 students stated that geometry was important and there was a 28 point spread between the percentage of low-achieving and high-achieving students who held this view.

An examination of the matrices dealing with the other attitude components indicates similar results. Of those Grade 10 students who scored in the highest achievement category, approximately 83% considered geometry to be easy and about 75% indicated that they liked it. These values are 41 and 39 percentage points, respectively, higher than the percentage of students in the lowest achievement categories who found geometry easy or who liked it. The difference between the high and low scoring Grade 7 students in each of these categories, however, was only 26 and 16 percentage points, respectively.

Overall, students in Grade 7 appear to view geometry more favourably and to achieve higher scores on the geometry unit than students in Grade 10 . As previously noted, a greater percentage of Grade 7 than Grade 10 students considered geometry to be important. Likewise, about 74% of the Grade 7 students found geometry to be easy and 70% liked it whereas the corresponding percentages for Grade 10 were 61% and 54%. Also, approximately 41% of the Grade 7 students obtained scores of 60% or more on the geometry unit as compared to the 33% of Grade 10 students who achieved scores in this range.

Grade 7–Data Analysis

The data analysis strand of the assessment was examined for Grade 7 students in the same manner as the other material. Tables 18 through 20 illustrate the findings of this work.

Table 18

Grade 7: Chi-Square Analysis
Importance of Data Analysis and Achievement in Data Analysis

		Achievement (percent)					
		0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
Importance	Not Important	2.3%	2.3%	2.7%	1.8%	1.0%	10.0%
	Expected Value	1.5%	2.0%	2.5%	2.4%	1.6%	
	Important	12.9%	17.9%	22.5%	22.0%	14.7%	90.0%
	Expected Value	13.7%	18.2%	22.6%	21.4%	14.1%	
	Total	15.2%	20.2%	25.1%	23.8%	15.7%	N=7349 100%

Chi-square = 69.8; D.F. = 4; significance level = 0.0000

Table 19

Grade 7: Chi-Square Analysis
Difficulty of Data Analysis and Achievement in Data Analysis

Difficulty		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Difficult	6.1%	5.3%	5.4%	4.0%	1.6%	22.5%
	Expected Value	3.5%	4.5%	5.6%	5.4%	3.5%	
	Easy	9.3%	14.8%	19.6%	19.8%	14.1%	77.5%
	Expected Value	11.9%	15.6%	19.4%	18.5%	12.1%	
	Total	15.4%	20.1%	25.0%	23.8%	15.7%	N=6863 100%

Chi-square = 315.3; D.F. = 4; significance level = 0.0000

Table 20

Grade 7: Chi-Square Analysis
Likeability of Data Analysis and Achievement in Data Analysis

Likeability		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Dislike	5.4%	5.2%	5.7%	5.1%	3.1%	24.6%
	Expected Value	3.9%	4.9%	6.1%	5.8%	3.8%	
	Like	10.5%	14.9%	19.3%	18.6%	12.2%	75.4%
	Expected Value	12.0%	15.2%	18.8%	17.8%	11.6%	
	Total	16.0%	20.1%	24.9%	23.6%	15.4%	N=6912 100%

Chi-square = 76.6; D.F. = 4; significance level = 0.0000

The Grade 7 data analysis results were similar to the Grade 10 findings in that all three matrices had a chi-square value which was significant at the 0.0000 level. Thus, there appears to be a relationship between the attitudes of Grade 7 students towards data analysis and their achievement in this area. The Grade 7 results also parallelled the Grade 10 findings in that there were more low achievers who had negative views towards data analysis than the expected value and there were more high achievers with positive views than expected.

As was the case with the geometry results, more Grade 7 students held favourable views towards data analysis and achieved better results than did Grade 10 students. Also, the percentage of Grade 7 students who liked data analysis, found it easy, and considered it important was more consistent across the five achievement levels than it was for the Grade 10 students. There was a greater gap between the percentage of high and low achievers in Grade 10 who held favourable views towards data analysis than between the high and low achievers in Grade 7.

Streaming–Mathematics 10 and Mathematics 10A

This study also investigated if the relationship between achievement and attitude towards data analysis and geometry was different for students taking different mathematics courses. As reported earlier, the students in Grade 10 who participated in this study were enrolled in two different courses–Mathematics 10 and Mathematics 10A. These two courses share approximately 30% of their curriculum content in common. Mathematics 10 is the Grade 10 mathematics course which is a requirement for acceptance into university. Mathematics 10A is the mathematics course which is often chosen by students who do not intend to pursue post-secondary school studies. Data concerning these two groups of students were used as the basis for this investigation.

Mathematics 10 and Mathematics 10A–Geometry

The data pertaining to students in Grade 10 were separated into two groups–Mathematics 10 and Mathematics 10A–and an analysis of the material, similar to that undertaken for all of the Grade 10 data, was done. Tables 21 through 23 on the following pages contain the findings of the analysis of the Mathematics 10 and Mathematics 10A data concerning geometry.

For Mathematics 10, all three matrices linking achievement in geometry to attitude towards geometry had chi-square values with levels of significance of 0.0000. For Mathematics 10A, the matrices concerned with the difficulty and likeability of learning geometry were also significant at 0.0000. The matrix concerned with the importance of learning geometry had a significance level of 0.0001. Thus, it seems that, for students enrolled in either Mathematics 10 or Mathematics 10A, achievement in geometry is related to each of the three components of attitude.

The nature of this relationship between performance and attitude appears to be similar, though not identical, for students enrolled in either course. Overall, students in the Mathematics 10A classes had less favourable attitudes towards geometry than students in the Mathematics 10 classes. They also achieved poorer results on the geometry unit. Only 9% of the Mathematics 10A students had a geometry score of higher than 60% whereas approximately 41% of the Mathematics 10 students scored in this range.

The number of students in Mathematics 10 and Mathematics 10A who achieved less than or equal to 20% on the geometry section and who also had negative views towards the subject was greater than the expected value for this cell in the matrices. Likewise, for both courses, the number of students who had favourable views concerning geometry and who achieved scores higher than 80% was greater than the expected value. However, the relationship between the number of students performing in the 40% to 60% range and the expected value for these cells was not the same for Mathematics 10 and Mathematics 10A.

Table 21

Mathematics 10 & 10A: Chi-Square Analysis
Importance of Geometry and Achievement in Geometry

Mathematics 10

Importance		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Not Important	4.1%	9.1%	10.0%	7.7%	2.6%	33.5%
	Expected Value	2.8%	7.2%	9.8%	9.3%	4.4%	
	Important	4.4%	12.3%	19.2%	20.0%	10.6%	66.5%
	Expected Value	5.6%	14.3%	19.4%	18.4%	8.8%	
	Total	8.5%	21.4%	29.2%	27.7%	13.2%	N=8025 100%

Chi-square = 253.7; D.F. = 4; significance level = 0.0000

Mathematics 10A

Importance		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Not Important	13.3%	18.8%	5.5%	2.8%	0.2%	40.6%
	Expected Value	11.4%	19.5%	6.1%	3.3%	0.3%	
	Important	14.7%	29.1%	9.6%	5.4%	0.6%	59.4%
	Expected Value	16.7%	28.5%	9.0%	4.8%	0.4%	
	Total	28.0%	47.9%	15.1%	8.1%	0.8%	N=2653 100%

Chi-square = 24.9; D.F. = 4; significance level = 0.0001

Table 22

Mathematics 10 & 10A: Chi-Square Analysis
Difficulty of Geometry and Achievement in Geometry

Mathematics 10

Difficulty		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Difficult	5.0%	10.9%	11.1%	7.2%	2.2%	36.3%
	Expected Value	3.1%	7.8%	10.5%	10.1%	4.8%	
	Easy	3.5%	10.6%	17.8%	20.7%	11.0%	63.7%
	Expected Value	5.4%	13.7%	18.5%	17.8%	8.4%	
	Total	8.5%	21.5%	29.0%	27.9%	13.2%	N=8734 100%

Chi-square = 649.3; D.F. = 4; significance level = 0.0000

Mathematics 10A

Difficulty		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Difficult	16.4%	23.7%	5.3%	2.6%	0.2%	48.1%
	Expected Value	13.9%	22.8%	7.3%	3.8%	0.3%	
	Easy	12.5%	23.8%	9.8%	5.3%	0.5%	51.9%
	Expected Value	15.0%	24.6%	8.0%	4.0%	0.4%	
	Total	28.9%	47.5%	15.1%	7.8%	0.7%	N=2819 100%

Chi-square = 80.1; D.F. = 4; significance level = 0.0000

Table 23

Mathematics 10 & 10A: Chi-Square Analysis
Likeability of Geometry and Achievement in Geometry

Mathematics 10

		Achievement (percent)					
		0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
Likeability	Dislike	5.4%	12.3%	12.9%	9.0%	3.1%	42.7%
	Expected Value	3.6%	9.4%	12.4%	11.9%	5.4%	
	Like	3.1%	9.7%	16.0%	18.8%	9.6%	57.3%
	Expected Value	4.9%	12.6%	16.5%	15.9%	7.3%	
	Total	8.5%	22.0%	23.9%	27.8%	12.7%	N=8501 100%

Chi-square = 508.8; D.F. = 4; significance level = 0.0000

Mathematics 10A

		Achievement (percent)					
		0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
Likeability	Dislike	19.3%	26.5%	6.5%	3.2%	0.3%	55.8%
	Expected Value	16.6%	25.9%	8.5%	4.4%	0.4%	
	Like	10.5%	19.9%	8.8%	4.7%	0.5%	44.2%
	Expected Value	13.2%	20.5%	6.8%	3.5%	0.3%	
	Total	29.3%	46.4%	15.3%	7.8%	0.7%	N=2811 100%

Chi-square = 82.0; D.F. = 4; significance level = 0.0000

There were fewer students than expected in Mathematics 10 who had favourable views of geometry and who were also achieving in the 40% to 60% range whereas in Mathematics 10A the reverse situation occurred. There were a greater number of students than expected achieving scores in this range.

In general, for students in either course, as the level of achievement increased so too did the percentage of students who held favourable views regarding geometry. Students in Mathematics 10 and Mathematics 10A who obtained scores of less than or equal to 20% seem to share comparable views as to the importance, difficulty, and likeability of geometry. For both courses, approximately 52% of the students in this category stated that geometry was important. Approximately 37% of these Mathematics 10 students liked geometry which was only 2% more than the percentage of Mathematics 10A students who liked it. There was also only 2 points difference between the percentage of low-achieving Mathematics 10A students who found geometry easy as compared to the percentage of low-achieving Mathematics 10 students who expressed this attitude.

As the performance level of the students improved, however, greater differences in the views of the students appeared. Among students who achieved scores higher than 60%, a larger percentage of the Mathematics 10 students than the Mathematics 10A students considered geometry favourably. There was an 8–point to 10–point difference between the percentage of Mathematics 10 students who stated that geometry was important, easy, or likeable as compared to the percentage of Mathematics 10A students who held these views.

Mathematics 10 and Mathematics 10A–Data Analysis

All six matrices concerning Mathematics 10 and Mathematics 10A students and their work with data analysis had chi-square values which were significant at the 0.0000 level. Once again it can be concluded that, for students enrolled in Mathematics 10 or Mathematics 10A, there is a relationship between performance in data analysis and attitudes towards data analysis. The results of the analysis of this data can be found in Tables 24 through 26 on the following pages.

As was the case with geometry, the Mathematics 10A students considered data analysis to be less important, more difficult, and less likeable than did the Mathematics 10 students. The students in the Mathematics 10A courses also achieved lower scores on the data analysis achievement section than did the students in Mathematics 10. Approximately 43% of the Mathematics 10 students scored over 60% on this unit whereas only 11% of the Mathematics 10A students scored in this range. In general, for both courses, the higher the achievement level, the greater the percentage of students who viewed data analysis favourably.

However, data analysis results were unlike the geometry results in that at all achievement levels there were differences between the percentages of students who viewed data analysis positively. At all five levels, a greater percentage of Mathematics 10 students than Mathematics 10A students considered data analyis to be important, easy, and enjoyable.

The data analysis results parallelled the geometry results in that there were more than the expected number of students in both courses who obtained less than 40% on the achievement portion and who held unfavourable views towards data analysis. Also, for the "easy" and "like" matrices, there were more than the expected number of students who had scores greater than 60% and who indicated favourable views towards data analysis. The matrix describing Mathematics 10A students' attitudes towards the importance of data analysis and their achievement in this area differed from all other matrices which describe Grade 10 data. In this matrix, the number of students achieving scores higher than 80% who also considered data analysis to be important was less than the expected value for this cell.

Table 24

Mathematics 10 & 10A: Chi-Square Analysis
Importance of Data Analysis and Achievement in Data Analysis

Mathematics 10

Importance		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Not Important	2.7%	3.3%	3.3%	2.6%	1.7%	13.7%
	Expected Value	1.7%	2.7%	3.5%	3.4%	2.5%	
	Important	9.7%	16.2%	22.2%	21.8%	16.4%	86.3%
	Expected Value	10.7%	16.8%	22.0%	21.1%	15.6%	
	Total	12.4%	19.5%	25.5%	24.5%	18.1%	N=6532 100%

Chi-square = 87.9; D.F. = 4; significance level = 0.0000

Mathematics 10A

Importance		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Not Important	7.5%	7.3%	10.1%	1.4%	0.6%	26.9%
	Expected Value	5.6%	6.1%	12.3%	2.3%	0.6%	
	Important	13.2%	15.5%	35.5%	7.3%	1.6%	73.1%
	Expected Value	15.1%	16.7%	33.3%	6.3%	1.6%	
	Total	20.7%	22.8%	45.6%	8.7%	2.2%	N=2168 100%

Chi-square = 48.4; D.F. = 4; significance level = 0.0000

Table 25

Mathematics 10 & 10A: Chi-Square Analysis
Difficulty of Data Analysis and Achievement in Data Analysis

Mathematics 10

Difficulty		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Difficult	6.7%	8.1%	9.7%	7.3%	3.8%	35.6%
	Expected Value	4.7%	6.6%	8.9%	8.7%	6.7%	
	Easy	6.4%	10.3%	15.4%	17.2%	15.1%	64.4%
	Expected Value	8.4%	11.9%	16.1%	15.8%	12.2%	
	Total	13.1%	18.4%	25.0%	24.5%	18.9%	N=5042 100%

Chi-square = 220.3 D.F. = 4; significance level = 0.0000

Mathematics 10A

Difficulty		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Difficult	12.6%	11.4%	18.1%	2.9%	0.7%	45.6%
	Expected Value	10.1%	9.8%	21.0%	3.7%	0.9%	
	Easy	9.6%	10.2%	28.1%	5.3%	1.3%	54.4%
	Expected Value	12.1%	11.7%	25.1%	4.4%	1.1%	
	Total	22.2%	21.6%	46.2%	8.1%	1.9%	N=1804 100%

Chi-square = 50.0; D.F. = 4; significance level = 0.0000

Table 26

Mathematics 10 & 10A: Chi-Square Analysis
Likeability of Data Analysis and Achievement in Data Analysis

Mathematics 10

Likeability		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Dislike	7.7%	9.0%	10.5%	9.0%	6.4%	42.6%
	Expected Value	5.9%	8.0%	10.8%	10.1%	7.9%	
	Like	6.1%	9.7%	14.7%	14.8%	12.1%	57.4%
	Expected Value	7.9%	10.7%	14.5%	13.7%	10.6%	
	Total	13.7%	18.7%	25.3%	23.8%	18.5%	N=4856 100%

Chi-square = 94.2; D.F. = 4; significance level = 0.0000

Mathematics 10A

Likeability		Achievement (percent) 0 - 20	20.1 - 40	40.1 - 60	60.1 - 80	80.1 - 100	Row Total
	Dislike	13.0%	12.5%	21.8%	3.1%	0.7%	51.1%
	Expected Value	10.9%	11.4%	23.8%	4.1%	0.8%	
	Like	8.4%	9.9%	24.9%	4.9%	0.9%	48.9%
	Expected Value	10.4%	10.9%	22.8%	3.9%	0.8%	
	Total	21.4%	22.4%	46.6%	8.0%	1.6%	N=1742 100%

Chi-square = 32.4; D.F. = 4; significance level = 0.0000

Grade 10–Non-participation of Students

In the 1990, there was almost full participation by students in Grades 4 and 7 in the British Columbia Mathematics Assessment. However, only 84% of the Grade 10 students in the province participated in the assessment. There is no information available as to the reasons why certain students did not participate, nor is there any data which describes the mathematical ability of these absentee students or their attitudes towards mathematics. As the sample for this study was drawn from the assessment data, the statistical significance of having 16% of the students not participate was investigated to determine if it held any implications for this study.

The students who did not participate in the assessment could have been a representative sample of the entire Grade 10 student population. If this was the case, then the non-participation of the these students would not have an impact on this study. The smallest Grade 10 sample analyzed contained 6598 subjects. Even though this value is less than half the number of students who were enrolled in Grade 10 in British Columbia in 1989, it is still a large sample size.

However, as discussed in Chapter 3, it is more likely that the individuals who did not take part in the assessment had either withdrawn from school, were absent on the day of the assessment, or were discouraged from participating. If these assumptions are correct, then these students would not form a representative sample of the general student population. Instead, many of the Grade 10 students who did not take part in the assessment might have been students of weak mathematical ability or students with little interest in school or in mathematics.

In order to explore the potential impact on the findings of this missing information, the following points were taken into consideration. For each of the matrices which dealt with the Grade 10 data, a chi-square analysis was performed. A chi-square value is obtained by subtracting the expected number (E) from the observed number in each cell of a matrix. The square of (O - E) is then divided by E. The subsequent values for each cell are then added to produce the final chi-square value for the matrix.

The chi-square value can be reduced in size by increasing the number of cells where (O - E) is equal to zero. The participation of more Grade 10 students in the assessment could reduce the size of a chi-square value of a matrix and, thus, its subsequent significance level. If the missing students were placed in cells where O was less than E so as to make O equal to E, then the chi-square value would lessen in size.

In each of the matrices dealing with Grade 10 data, there were five cells with O less than E and all of the cells, except one, had a chi- square value which was significant at the 0.0000 level. In order to examine the potential impact of the missing Grade 10 information, the matrix where the chi-square value was 0.0001 was selected for study. This matrix dealt with the Mathematics 10A data and can be found in Table 21. The values in the matrix were manipulated in the following manner. Each of the five cells where O was less than E was changed so that O was equal to E. A new chi-square value was then calculated and was found to be 12.97. This value has a significance level between 0.01 and 0.02. This resulting level of significance is different than the original value but, for the purposes of this study, it still represents a reasonable value.

CHAPTER 5

SUMMARY AND CONCLUSIONS

This study was undertaken to determine the nature of the relationship between high school students' attitudes towards particular mathematics topics and their achievement in those areas. The sample used in this work was drawn from the data collected by the 1990 British Columbia Mathematics Assessment of students in Grades 7 and 10 in the province. These data were then investigated through the use of chi-square analysis. The specific mathematical topics which were the focus of this research were geometry and data analysis. The study of the relationship between attitudes and achievement included an examination of the role of grade level and student ability.

Presented in the following sections are conclusions based on the findings of this work. Implications of the results and the limitations of the study are then discussed. The chapter concludes with proposed suggestions for further research.

Findings and Conclusions

The four research questions listed in Chapter 1 were addressed through the analysis of the data obtained from the 1990 British Columbia Mathematics Assessment. Each of these questions is stated below and a discussion of the relevant findings and conclusions is presented immediately after each question. The first question reads as follows:

1. What relationships exist between students' attitudes towards the geometry and data analysis domains of the mathematics curriculum and students' achievement in those domains?

The results of this study support the findings of many researchers that there is a connection between attitude and performance in mathematics (Brassell, Petry, & Brooks, 1980; Campbell & Schoen, 1972; Hembree, 1990; Tsai & Walberg, 1983). In order to answer the above question, the assessment data for students in Grade 10 were examined. The chi-square analysis of these data showed that there was a significant relationship between students' attitudes towards geometry and data analysis and their performance in those strands. This relationship existed for each of the three investigated components of attitude.

The chi-square value for each of the six matrices which were designed to study these relationships was 0.0000. As this value was the same in all six cases, it did not provide sufficient information to determine if the nature of the relationship between attitude and achievement was different for each of the components of attitude and each of the mathematics topics. Likewise, as the sample size for the study was large, a chi-square value of 0.0000 is not an unexpected result and does not necessarily indicate the strength of the relationship.

A further examination of the patterns present in the data, however, suggests that there is a strong connection between performance in geometry and data analysis and students' perceptions of these topics. Grade 10 students who were achieving good results in geometry were likely to view it as being important, easy, and enjoyable. Students who were obtaining poor results were likely to hold the opposite viewpoint. Similar results were found for the easy/difficult and like/dislike components of attitude and their relationship to achievement in data analysis. Approximately the same percentage of students considered data analysis to be easy and likeable as held these views about geometry.

The relationship between students' views as to the importance of data analysis and their performance in this area differed from the other findings in that approximately 85% of the students considered data analysis to be important. There was little difference between the expected value and the actual number of high-scoring students who thought that data analysis was important. The majority of the students who did not consider data analysis to be important achieved scores of less than 60%.

Earlier work determined that students may have different attitudes towards different mathematical topics and that they do not necessarily achieve the same results on all domains of the mathematics curriculum (Hogan, 1977; Kifer & Robitaille, 1989). This research, however, suggests that the relationship between achievement and the 'easy/difficult' and 'like/dislike' components of attitude is similar for both the data analysis and geometry domains of the mathematics curriculum.

As was noted previously, the relationship between the 'importance' component of attitude and students' performance in mathematics is not the same for all topics. It is not clear from this initial analysis if these differing results are due to the particular domains of the curriculum under study or if they are a function of the 'importance' component of attitude.

The second question which was researched is stated below:

2. What relationships exist among students' overall mathematics ability, their achievement in the geometry and data analysis domains, and their attitudes towards these topics?

The response to this question was based on a further analysis of the Grade 10 data. On both the geometry and data analysis units, Grade 10 students achieved higher scores than on the overall assessment and the distribution of the assessment scores was different than the distribution of the scores for specific topics. However, significant relationships between attitudes towards data analysis and geometry and overall achievement in mathematics were determined for each of the three components of attitude studied. The chi-square value for each of the matrices which examined these relationships was significant at the 0.0000 level.

The patterns which emerged within the data concerning geometry and overall achievement were similar to those which occurred with the data relating to achievement within the geometry domain. The percentage of students who viewed geometry favourably and achieved high scores was similar in both cases as was the percentage of students who had low scores and negative views.

Different results were found for data analysis. The relationship between performance and attitude within the matrices was not the same for overall achievement as it was for achievement within the data analysis unit. At each achievement level, the percentage of students who found data analysis to be important, easy, or likeable was not the same for each set of matrices.

Therefore, it can be concluded that, as stated previously, there is an association between attitudes towards specific topics within the mathematics curriculum and overall achievement in mathematics. However, this relationship will not necessarily be the same as the relationship that exists between performance within a particular domain of the curriculum and attitudes towards that domain. Similar patterns existed for the geometry unit but not for the data analysis unit.

The third research question focused on the impact of the student's grade level and reads as follows:

3. What differences, if any, exist in the nature of the relationships in questions 1 and 2 among students at different grade levels?

The assessment data concerned with Grade 7 and Grade 10 students provided the basis for the study of this question. Five of the six matrices designed to illustrate the connection between performance by Grade 7 students in the areas of geometry and data analysis and the three attitude components had a chi-square value of 0.0000. The exception was the matrix dealing with the importance of geometry which had a chi-square value of 0.0013. Thus, in five out of six possible cases, the relationship between attitude and performance was similar for Grade 7 and Grade 10 students in that this relationship was found to be significant at the same level.

The Grade 7 students generally held more favourable views towards geometry and data analysis and achieved better results than did the students in Grade 10. The Grade 7 and Grade 10 results differed in that the gap between the percentage of high and low achievers who held favourable views towards geometry and data analysis was greater for students in Grade 10 than for students in Grade 7.

However, an examination of the five matrices referred to previously indicated that some of the patterns that had emerged within the Grade 10 data were also present within the Grade 7 data. There were more than the expected number of students who considered geometry to be easy or enjoyable, or data analysis to be important, easy, or enjoyable, who also achieved good achievement scores in these areas. Likewise, there were more than the expected number achieving poor scores who also held unfavourable views in these five areas. The gap between expected value and actual value was lowest for students in the middle performance range.

Unlike the Grade 10 students, approximately 88% of the Grade 7 students considered geometry to be important. At all five achievement levels, at least 85% of the students held this view. These results are similar to those determined for Grade 10 and data analysis. In that case, 83% of the students indicated that the topic was important.

The previous discussion suggests that the relationship between achievement and the 'easy/difficult' and 'like/dislike' components of attitude may be the same for students in different grade levels. These findings differ from those of other studies (Newman, 1984; Taylor & Robitaille, 1987) whose results linked the relationship between attitude and performance to the grade level of the student. However, as was noted in the response to question 1, it appears that the 'importance' component of attitude may have a different relationship to attitude depending upon the topic or grade level under consideration.

The final question posed by this study was as follows:

4. What differences, if any, exist in the relationships in questions 1 and 2 among students in the same grade who are enrolled in different mathematics courses?

In order to answer this question, data relating to the views and performance of students enrolled in Mathematics 10 and Mathematics 10A was examined. Mathematics 10 students at all achievement levels held more favourable views towards data analysis than did Mathematics 10A students. For geometry, the percentage of low-scoring students in both courses who viewed geometry unfavourable was almost the same. As the achievement level rose, the gap between the views of the Mathematics 10 and Mathematics 10A students grew larger.

Similar relationships between attitudes towards geometry and data analysis and achievement in those areas were found for students enrolled in these courses in that, for five out of six cases, the chi-square values for the matrices concerned with these data were significant at the 0.0000 level. The significance level for the remaining matrix was 0.0001. In general, for the students enrolled in Mathematics 10 and Mathematics 10A, the higher the achievement level, the more they liked geometry and data analysis and the more they considered them to be important and easy.

These results suggest that, although students in different courses may have different attitudes towards certain topics, the relationship between attitude and performance will follow the same general patterns. However, these patterns will not necessarily be identical for each topic studied and may differ depending upon the achievement level of the student.

Implications

The results of this study affirm the need for mathematics educators to be aware of the impact of the affective domain on the learning process in mathematics. Although the findings did not investigate the cause and effect relationship between performance and attitude, educators should recognize that there may be an interaction between these two variables. As this relationship seems to exist for different domains of the curriculum as well as for students of varying ability and in different grade levels, its existence needs to be recognized by educators working with students at all levels of the mathematics curriculum. The findings also emphasize the complex nature of the relationship between attitude and performance. Teachers may always have assumed that students with favourable attitudes towards mathematics will generally perform well and those achieving low scores will have negative attitudes. Teachers also should be aware that these relationships may vary with the particular component of attitude expressed, with the individual topic under study, and with the grade level of the student. Flexibility in dealing with students' performance and their attitudes is required.

Of further interest is the observation that students may view mathematics, not as a global discipline, but rather as one composed of varying strands. Students appear to differentiate among these strands and also to differentiate among their own perceptions of these strands. As students appear to be able to reflect metacognitively on these concepts, teachers should encourage students to do so.

Limitations of the Study

This study investigated the relationship between attitudes towards certain domains of the mathematics curriculum and achievement in mathematics. The following conditions are limitations on this work.

The definitions of the terms geometry and data analysis are based on the implied definitions of these terms as used in the British Columbia mathematics curriculum guide. Student definitions of these terms, however, may differ from that of the curriculum. As an example, one of the topics about which the Grade 10 sample group was asked to indicate its views was trigonometry, which suggests that trigonometry and geometry are two separate topics. The British Columbia mathematics curriculum, however, includes trigonometry under the heading of geometry.

Another possible limitation is the reliability of student self-reporting of attitudes. It is assumed that students have the ability to accurately evaluate their own attitudes. It is also assumed that students will choose to accurately report these attitudes.

Suggestions for Further Research

The results of this study have provided additional information regarding the complex relationship between attitudes towards mathematics and performance in this subject. This work, however, suggests a variety of additional questions which may have implications for further research.

The focus of this research was specifically on the geometry and data analysis domains of mathematics. However, little research has been done concerning attitudes and individual topics within the curriculum. A study of other mathematical topics, such as algebra and number theory, would clearly be needed before any generalized conclusions regarding attitudes and individual topics could be made. Likewise, the sample which formed the basis of this work involved students from grades seven and ten. Further work involving students at different grade levels is needed. Research which encompassed components of attitude other than those involved in this study would also broaden the framework of knowledge regarding attitudes towards particular domains of the curriculum. Attitude scales, such as the *Mathematics Attitude Inventory* and the *Fennema-Sherman Mathematics Attitude Scales*, which examine a wide range of domains of attitude and which have statistical evidence supporting their validity would be useful for this purpose.

Many of the findings of this study were based upon a descriptive analysis of the matrices designed to examine the data. A more empirical study of the data would allow for more specific information regarding the association between attitude and performance to be determined.

One issue which has only been briefly referred to in the literature is that of the cultural context within which the learning of mathematics takes place (Kifer & Robitaille, 1989; Hart, 1989). As societies become more multicultural in nature, it is important to understand the impact of culture on the relationship between attitude and performance in mathematics. It cannot be assumed that this relationship will necessarily be the same for all societal groups.

One further question which has only been minimally addressed is that of the causality of the relationship between attitude and achievement (Cheung, 1988; Newman, 1984). Although this may be a difficult question to precisely answer, it warrants, nonetheless, an examination.

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APPENDIX A

1990 British Columbia Mathematics Assessment Forms

Grade 10: Forms C and D

Grade 7: Form A

1990 BRITISH COLUMBIA MATHEMATICS ASSESSMENT

GRADE 10

FORM C

STUDENT FORM

85

BACKGROUND INFORMATION

For each item, shade in the appropriate space on the answer sheet.

1. Sex

   A) Male
   B) Female

2. Age

A)	14 or less	D)	17
B)	15	E)	18
C)	16	F)	19 or more

3. What program are you in?

   A) Regular program in English
   B) French Immersion
   C) Programme-cadre de français

4. What mathematics course are you currently taking (if you are not taking one this semester, which course did you take last semester)?

   A) Math 8
   B) Math 9
   C) Math 9A
   D) Math 10
   E) Math 10A
   F) Introductory Math 11
   G) Math 11A
   H) Math 11
   I) Algebra 11
   J) Algebra 12
   K) A mathematics course not on this list
   L) I am not taking a mathematics course this year.

5. Which of the following **best** describes the mathematics course you took or are taking this year?

   A) A ten-month course
   B) A semestered course beginning in September
   C) A semestered course beginning in January or February
   D) I am not taking a mathematics course this year.
   E) Other

6. What made you decide to take the mathematics course you are currently taking (or the one you took last semester)? **You many choose more than one response.**

   A) The counsellor suggested it.
   B) My parent(s) or guardian(s) suggested it.
   C) My last year's mathematics teacher suggested it.
   D) I decided on my own.
   E) I had no choice because of my marks in previous mathematics courses.
   F) It is required for the next mathematics course I want to take.
   G) Most of my friends take this course.
   H) I took the course because I am good at mathematics.
   I) Some other reason.

7. Which mathematics course(s) do you intend to take in both Grades 11 and 12? **Mark all that apply.**

   A) None
   B) Math 10
   C) Math 10A
   D) Math 11
   E) Introductory Math 11
   F) Math 11A
   G) Introductory Accounting 11
   H) Math 12
   I) Survey Math 12
   J) An enriched mathematics course (e.g. Advanced Placement, International Baccalaureate, Calculus, etc.)
   K) A mathematics course not on this list

8. What do you plan to do after leaving secondary school? **Choose one.**

   A) Attend a business school or technical college
   B) Attend a vocational, art, or trade training school
   C) Attend a community college: university transfer program
   D) Attend a community college: career program
   E) Attend university
   F) Look for a full-time job
   G) Take a year off and then return to school
   H) Take a year off and then look for a job
   I) Other plans
   J) Undecided

For the next three items, decide to what extent you agree or disagree.

9. You have to be able to do mathematics to get a good job.

A) Strongly Disagree
B) Disagree
C) Do not know
D) Agree
E) Strongly Agree

10. Most people use mathematics in their jobs.

A) Strongly Disagree
B) Disagree
C) Do not know
D) Agree
E) Strongly Agree

11. When I leave school, I would like a job where I have to use mathematics.

A) Strongly Disagree
B) Disagree
C) Do not know
D) Agree
E) Strongly Agree

For each of the next three items, three answers are needed.

A) Tell how <u>important</u> you think the topic is.
B) Tell how <u>easy</u> you think the topic is.
C) Tell how much you <u>like</u> the topic.

If you are not sure what a topic means, leave its three answers blank.

12. Geometry

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

13. Data Analysis

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

14. Trigonometry

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

For the next three items, think of your mathematics classes during a typical school week.

15. We use computers in our mathematics class.

A) Almost every period
B) Often
C) Sometimes
D) Rarely
E) Never

16. We have quizzes or tests in mathematics.

A) Almost every period
B) Often
C) Sometimes
D) Rarely
E) Never

17. We work in small groups in our mathematics class.

A) Almost every period
B) Often
C) Sometimes
D) Rarely
E) Never

ACHIEVEMENT SURVEY: Part 1, Items 1 - 20.

These items are to be answered by all students.

1. Mrs. Schmidt works in a local factory for $6.00 per hour, plus time and one-half after 40 hours. Last week she worked 45 hours. How much did she earn?

   A) $240

   B) $270

   C) $285

   D) $405

   E) I don't know.

2. Simplify: 30 – 4 (8 – 2)

   A) 0

   B) 20

   C) 156

   D) 6

   E) I don't know.

3. Which number is largest?

   A) $\frac{2}{3}$

   B) $\frac{4}{5}$

   C) $\frac{3}{4}$

   D) $\frac{5}{8}$

   E) I don't know.

4. Wendy bought 3 record albums on sale. The regular price was \$7.24 each and the sale price was \$1.50 off each record. If she paid 69¢ sales tax on her total purchase, how much money did she spend?

   A) \$17.22

   B) \$17.91

   C) \$21.72

   D) \$22.91

   E) I don't know.

5. What is the mean of the following numbers?

   2, 2, 2, 3, 4, 5, 10

   A) 3

   B) 2

   C) 10

   D) 4

   E) I don't know.

6. From the graph below, the temperature at a depth of 2.5 km is closest to

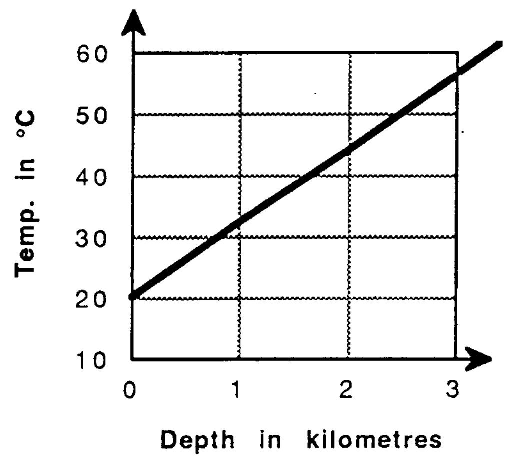
A) 30°C

B) 40°C

C) 50°C

D) 60°C

E) I don't know.



7. A bag contains 3 red marbles, 2 white marbles, and 20 black marbles. What is the probability of randomly choosing a white marble?

A) 0.08

B) 0.5

C) 0.92

D) 2.0

E) I don't know.

8. Two dice are rolled. What is the probability of rolling a total of 5?

A) $\frac{1}{9}$

B) $\frac{5}{36}$

C) $\frac{1}{18}$

D) $\frac{2}{9}$

E) I don't know.

9. ABCD is a parallelogram. If $\angle A = 105°$ determine $\angle B$.

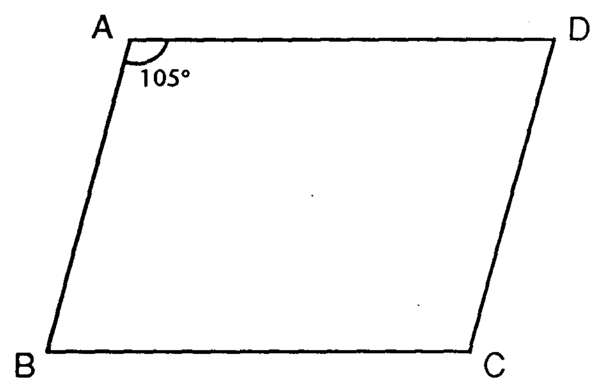
A) 75°

B) 95°

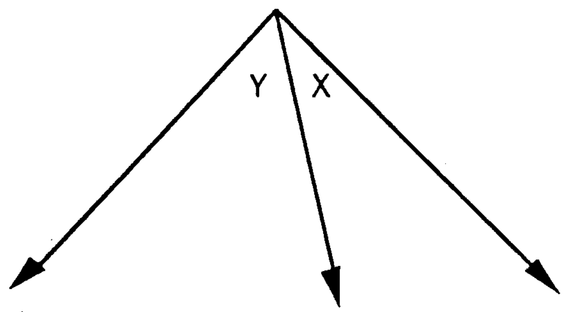
C) 105°

D) 255°

E) I don't know.



10. Angles X and Y in the figure below are complementary. If the measure of angle X is 24° less than the measure of angle Y, then angle X is



A) 48°

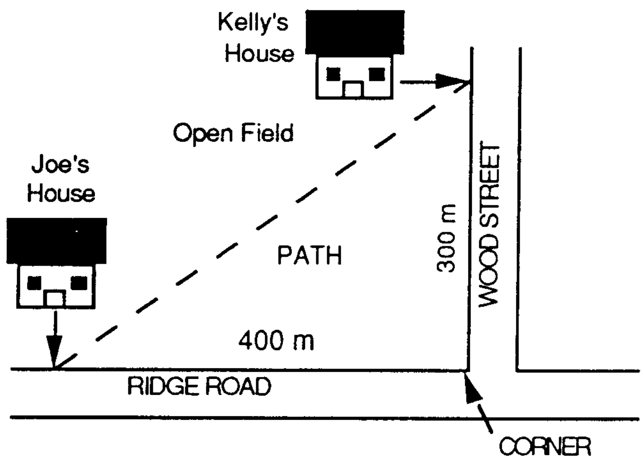
B) 23°

C) 57°

D) 33°

E) I don't know.

11. When Joe walks from his house to Kelly's house, he follows the path through the open field. How far does he walk?



A) 450 m

B) 500 m

C) 550 m

D) 600 m

E) I don't know.

12. Δ ABC is a right triangle. Determine the length of side AC.

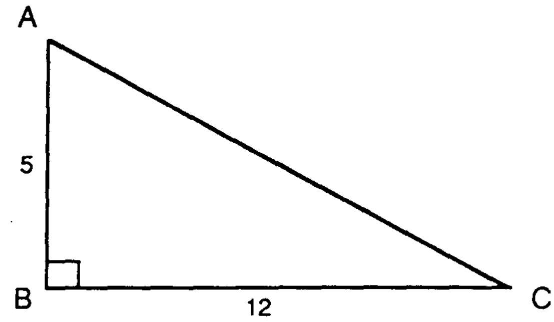
A) 13

B) 17

C) 49

D) 169

E) I don't know.



13. Find the perimeter of the figure below which consists of an equilateral triangle and a semi-circle.
(Use $\pi = 3.14$)

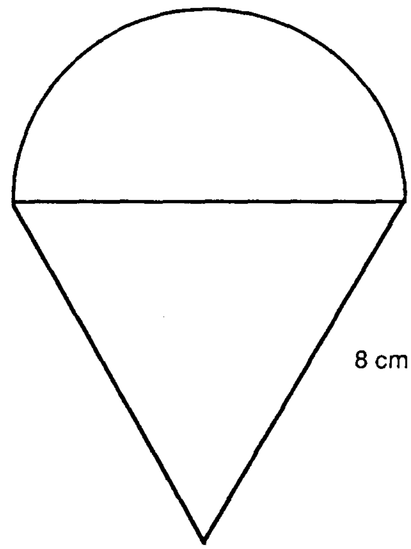
A) 41.1 cm

B) 33.1 cm

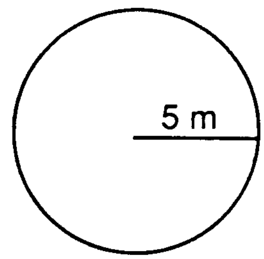
C) 28.6 cm

D) 20.6 cm

E) I don't know.



14. The best estimate for the area of the circle shown below is



A) 15 m^2

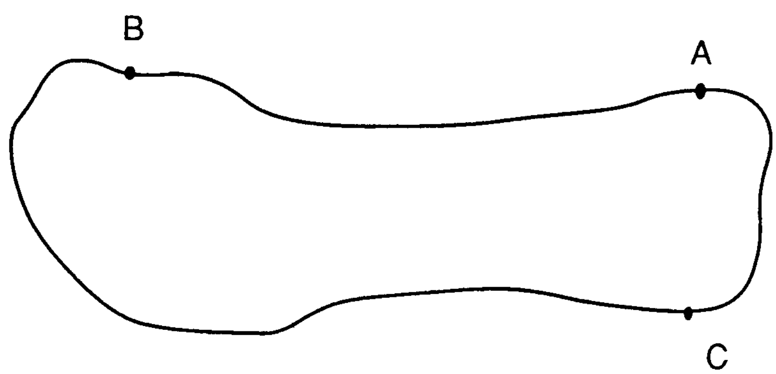
B) 75 m^2

C) 100 m^2

D) 5 m^2

E) I don't know.

15. Towns A, B, and C are on the shore of a lake as shown in the map below. The distance from A to B is 7.8 km and the distance from A to C is 2.4 km. Which one of the following is the best estimate for the area of the lake?



A) 10 km^2

B) 18 km^2

C) 14 km^2

D) 24 km^2

E) I don't know.

16. In the diagram below, the area of rectangle PQRS is 24 cm^2. What is the area of the parallelogram QVRS?

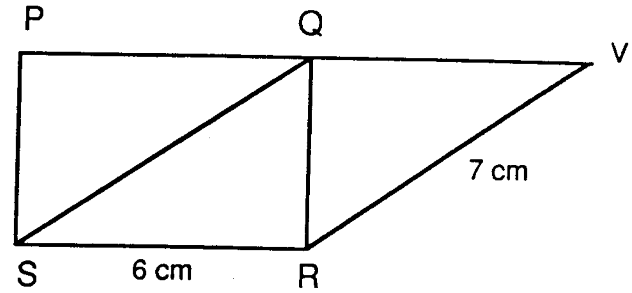
A) 48 cm^2

B) 36 cm^2

C) 24 cm^2

D) 18 cm^2

E) I don't know.



17. Simplify: $r + s - (r - s)$

A) 0

B) $2r + 2s$

C) $2r$

D) $2s$

E) I don't know.

18. Evaluate : $2 - (2 - x)$ when $x = -1$

A) 1

B) -1

C) 2

D) -2

E) I don't know.

19. Solve: $5.3x - 12 = 2.4x + 46$

A) $x = 2$

B) $x = 20$

C) $x = \frac{340}{29}$

D) $x = \frac{340}{77}$

E) I don't know.

20. If you divide any positive number by a number greater than 2, then the answer will be

A) less than half the original number.

B) more than half the original number.

C) a fraction.

D) impossible to predict.

E) I don't know.

This is the end of Part 1. Students who are currently taking Mathematics 10, or who did so last semester, go to Part 3 on page 24.
All others complete Part 2 beginning on the next page: Items 21 - 40.

ACHIEVEMENT SURVEY: PART 2, ITEMS 21-40

21. What is the value of $2^3 \times 3^2$?

A) 72

B) 36

C) 54

D) 48

E) I don't know.

22. Evaluate: $(3^{-1})^2$

A) $\frac{1}{9}$

B) -9

C) $-\frac{1}{9}$

D) 9

E) I don't know.

23. Evaluate: $\frac{6^2}{3}$

A) 12

B) 4

C) 108

D) 6

E) I don't know.

24. Linda's new bike cost $159.99 and the sales tax was 5%. How much did she pay including tax?

A) $164.99

B) $167.99

C) $172.98

D) $177.99

E) I don't know.

25. Written as a fraction in lowest terms, $\frac{1}{4}\% =$

A) $\frac{1}{4000}$

B) $\frac{1}{400}$

C) $\frac{1}{40}$

D) $\frac{1}{4}$

E) I don't know.

26. Evaluate: $4\frac{1}{5} + 3\frac{2}{5}$

A) $7\frac{3}{10}$

B) $\frac{38}{10}$

C) 2

D) $7\frac{3}{5}$

E) I don't know.

27. At a party the ratio of boys to girls was 2 to 1. What percent of the people at the party were girls?

A) $66\frac{2}{3}\%$

B) 50%

C) $33\frac{1}{3}\%$

D) 200%

E) I don't know.

28. Divide: $1\frac{1}{3} \div 2\frac{2}{3}$

A) $\frac{1}{3}$

B) $\frac{1}{2}$

C) $1\frac{1}{3}$

D) $\frac{32}{9}$

E) I don't know.

29. Multiply: $3\frac{1}{2} \times 2\frac{1}{7}$

A) $\frac{6}{14}$

B) $5\frac{9}{14}$

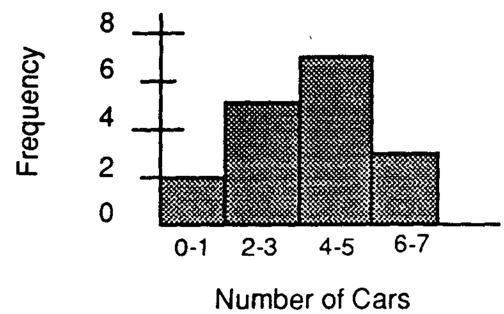
C) $6\frac{1}{14}$

D) $7\frac{1}{2}$

E) I don't know.

30. A table and a graph of the same data are shown below. What is the value of x?

Number of Cars	Frequency
0 or 1	2
2 or 3	x
4 or 5	7
6 or 7	3



A) 3

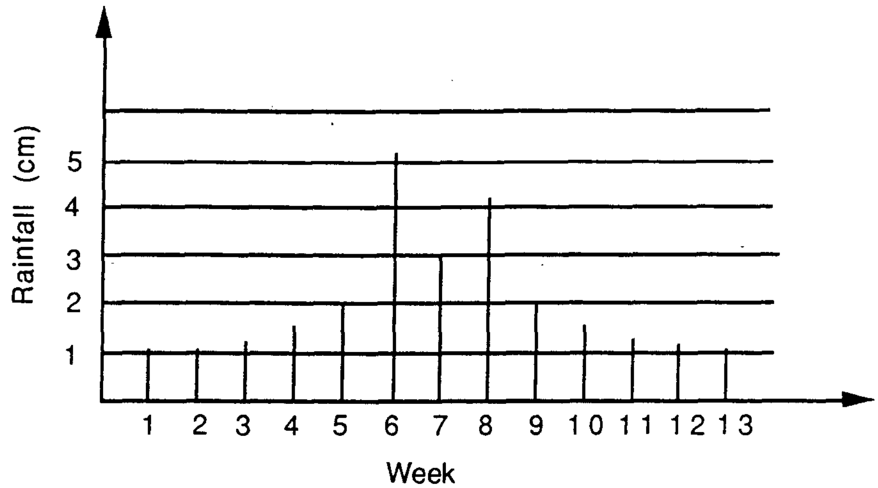
B) 4

C) 5

D) 6

E) I don't know.

31. In the graph below, rainfall in centimetres is plotted for 13 weeks. The average weekly rainfall during the period is approximately



A) 1 cm

B) 2 cm

C) 3 cm

D) 4 cm

E) I don't know.

32. The table below shows scores for a class on a 10-point test. How many in the class made a score GREATER than 7?

Test Score	Tally	Frequency
4	I	1
5	III	3
6	~~IIII~~ I	6
7	II	2
8	IIII	4
9	III	3
10	I	1

A) 2

B) 8

C) 10

D) 12

E) I don't know.

33. The coordinates of point Q are

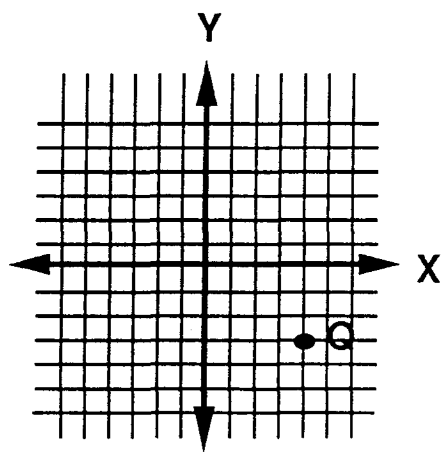
A) (− 4, 3)

B) (− 3, 4)

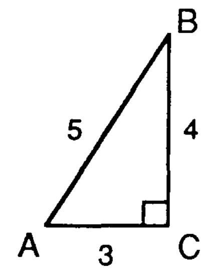
C) (3, − 4)

D) (4, − 3)

E) I don't know.



34. The cosine of $\angle$ A in the figure is equal to



A) $\frac{3}{5}$

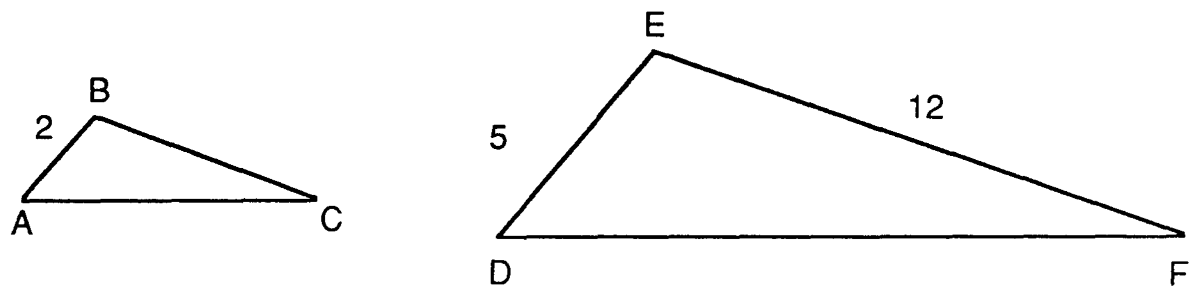
B) $\frac{3}{4}$

C) $\frac{4}{5}$

D) $\frac{5}{4}$

E) I don't know.

35. Δ ABC is similar to Δ DEF. Determine the length of side BC.



A) $\frac{10}{12}$

B) $\frac{24}{5}$

C) 5

D) 10

E) I don't know.

36. Δ ABC is a right triangle. If $\angle$ A = 40° and AC = 100, find AB.

$\sin 40° = 0.6428$
$\cos 40° = 0.7660$
$\tan 40° = 0.8391$

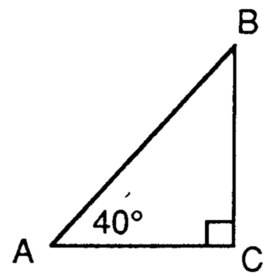
A) 64.28

B) 76.60

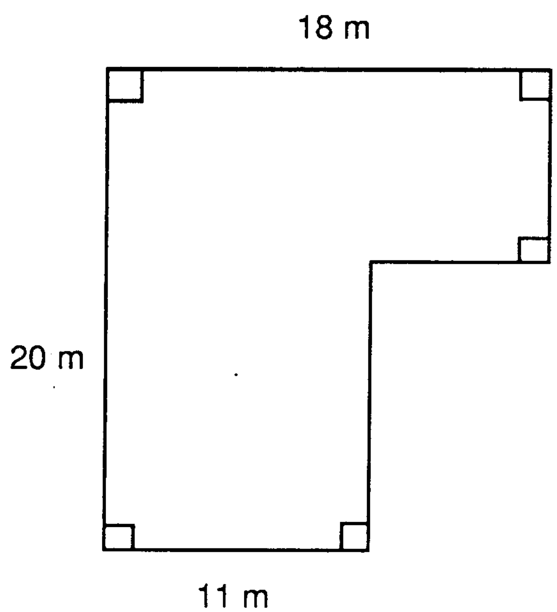
C) 130.5

D) 155.6

E) I don't know.



37. Determine the perimeter of this figure.



A) 49 m

B) 58 m

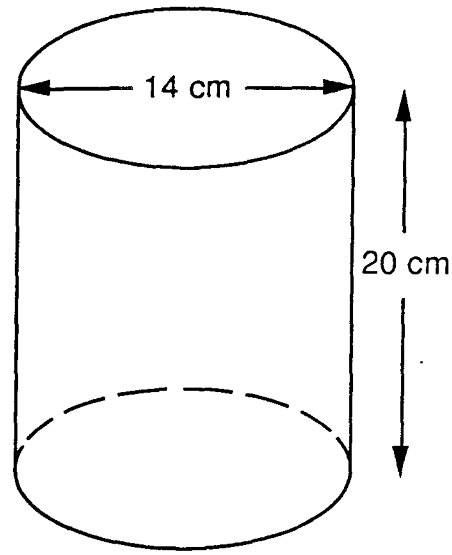
C) 76 m

D) 87 m

E) I don't know.

38. What is the approximate total surface area of the solid cylinder below? Use the formula

$$\text{Surface Area} = 2\pi r^2 + 2\pi rh.$$



A) 880 cm^2

B) 1187 cm^2

C) 308 cm^2

D) 934 cm^2

E) I don't know.

39. If $x = 4$, $y = 2$, and $z = 0.5$, the value of $2xy^2z$ is

A) 16

B) 32

C) 64

D) 128

E) I don't know.

40. Solve for x: $3x + 7 = 5x + 4$

A) $x = -\frac{11}{2}$

B) $x = -\frac{3}{2}$

C) $x = \frac{3}{2}$

D) $x = \frac{11}{2}$

E) I don't know.

This is the end of Part 2. Check your work
and hand in your booklet and answer sheet.

ACHIEVEMENT SURVEY: PART 3, ITEMS 41-60

This section is for students who are taking Math 10 now, or who took Math 10 last semester.

41. Find the sum in simplest radical form.

$$\sqrt{12} + \sqrt{27}$$

A) $5\sqrt{3}$

B) $\sqrt{39}$

C) 15

D) $3\sqrt{6}$

E) I don't know.

42. Find the difference in simplest radical form.

$$\sqrt{20} - \sqrt{5}$$

A) $\sqrt{15}$

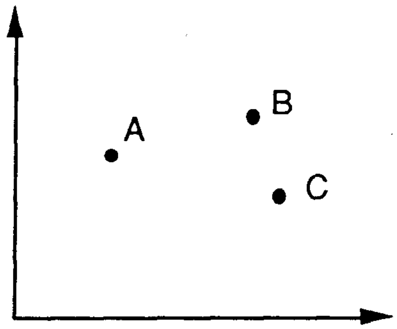
B) $\sqrt{5}$

C) $3\sqrt{5}$

D) 2

E) I don't know.

43. Points A, B, and C are plotted in the diagram below. If these points are supposed to lie on the same line, which one of the following statements can we conclude is true?



A) Point A is incorrectly plotted.

B) Point B is incorrectly plotted.

C) Point C is incorrectly plotted.

D) Any one of points A, B, or C is incorrectly plotted.

E) I don't know.

44. A collection of coins consists of 5 quarters, 2 dimes, 6 pennies, 3 nickels, and 4 one-dollar coins. What is the likelihood that if one is drawn at random, it will be a nickel?

A) 15%

B) 12%

C) 25%

D) 10%

E) I don't know.

45. If the lines $y = m_1x + b_1$, and $y = m_2x + b_2$ are parallel, then

A) $b_1 = b_2$

B) $y = x$

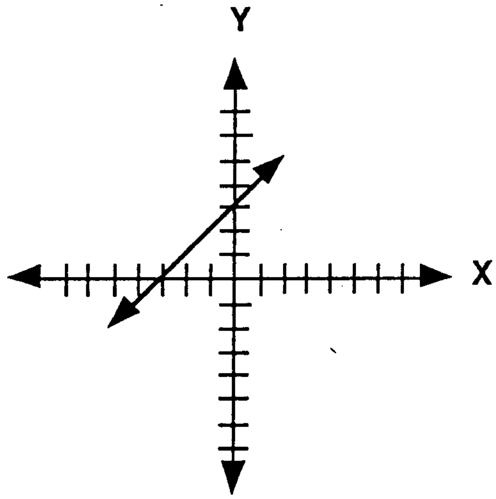
C) $m_1 = -\frac{1}{m_2}$

D) $m_1 = m_2$

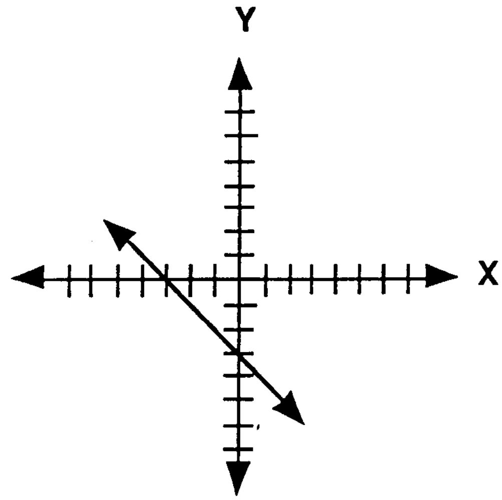
E) I don't know.

46. Which one of the following is the graph of $x + y = -3$?

A)



B)



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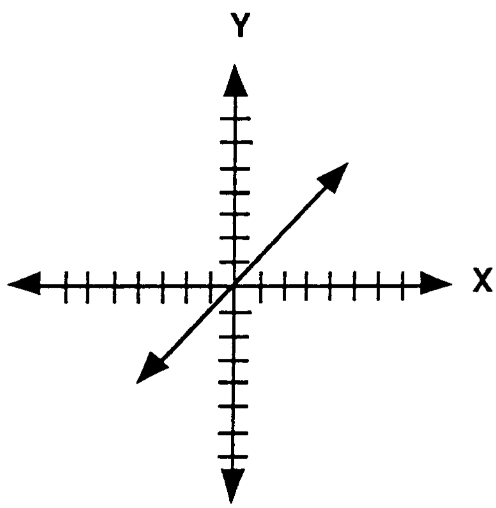

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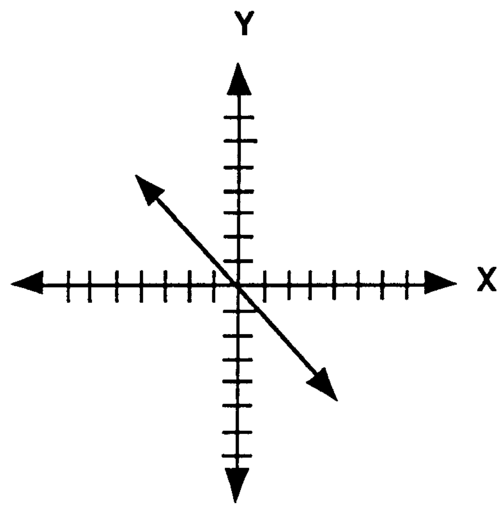


E) I don't know.

111

47. In the figure AB // DG and AC // FE. If $\angle 1 = 130°$ and $\angle 2 = 100°$, find $\angle$ AGH.

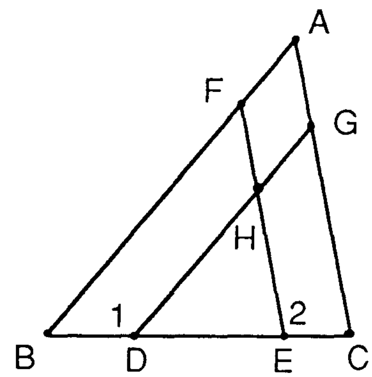
A) 80°

B) 100°

C) 130°

D) 150°

E) I don't know.



48. In the figure below, line NQ is parallel to line OP, NQ = 4 cm, OP = 6 cm, and MQ = 8 cm. Find the length of MP.

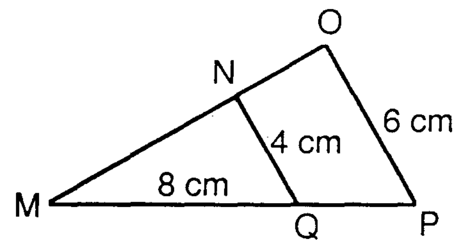
A) 10 cm

B) 12 cm

C) 14 cm

D) 16 cm

E) I don't know.



49. The figure below illustrates a water canal and a method of measuring its width. If PS = 24 m, PR = 2 m, and RT = 5 m, how wide is the canal?

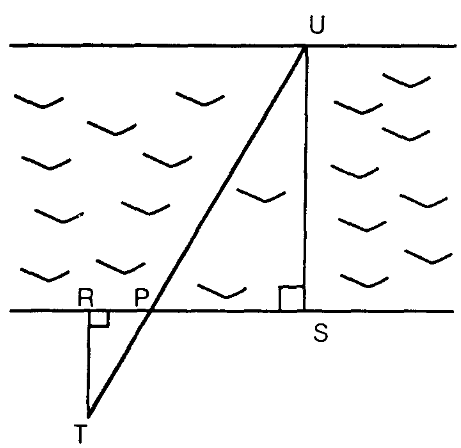
A) 24 m

B) 32 m

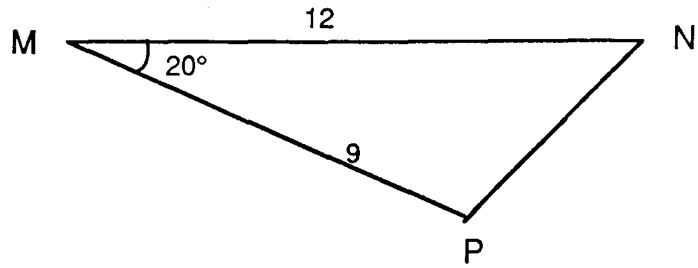
C) 40 m

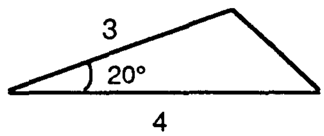
D) 60 m

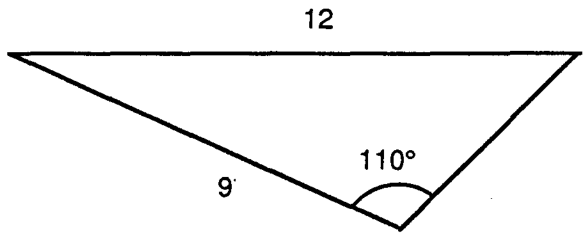
E) I don't know.

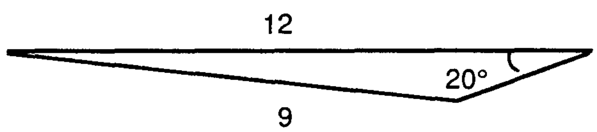


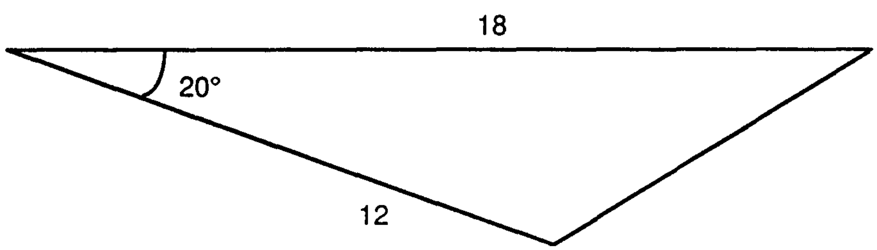
50. Which triangle can you be sure is similar to ΔMNP?



A) 

B) 

C) 

D) 

E) I don't know.

51. In triangle ABC, BD is the median to AC. What additional information is required to show that triangle ABD is congruent to triangle CBD?

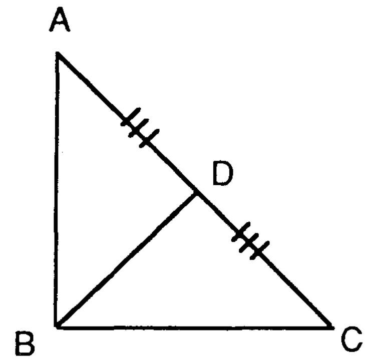
A) AB = CD

B) AB = BC

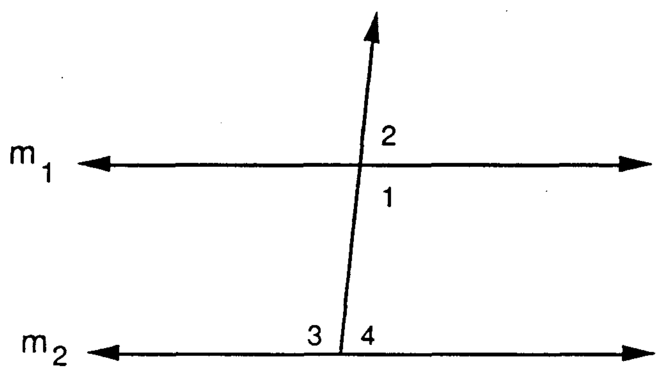
C) BD = AB

D) AC = BC

E) I don't know.



52. In order for m_1 to be parallel to m_2, which one of the following must be true?



A) $\angle 3$ and $\angle 4$ must both be right angles.

B) $\angle 1$ must have the same measure as $\angle 4$.

C) $\angle 1 + \angle 4$ must equal 180°.

D) $\angle 3$ must have the same measure as $\angle 2$.

E) I don't know.

53. Expand: $(a - 7)(a - 2)$

A) $a^2 - 5a + 14$

B) $a^2 - 9a - 14$

C) $a^2 - 9a + 14$

D) $a^2 - 14a - 9$

E) I don't know.

54. Factor completely over the rational numbers: $4a^2 - 8$

A) $(2a + 4)(2a - 2)$

B) $2(2a + 2)(a - 2)$

C) $2^2(a^2 - 2)$

D) $2^2(a + 2)(a - 1)$

E) I don't know.

55. Factor completely: $a^2 - 36b^2$

A) $(a - 12b)(a + 3b)$

B) $(a - 6b)(a - 6b)$

C) $(a - 6b)(a + 6b)$

D) $(a - 4b)(a + 9b)$

E) I don't know.

56. $A = 3n^2 - 2n + 5$. If $n = -2$, then the value of A is

A) -5

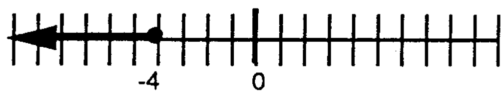
B) 10

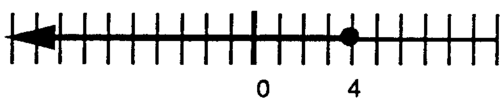
C) 15

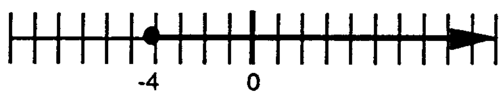
D) 21

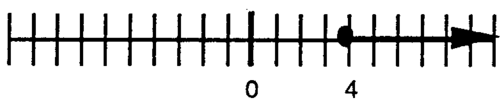
E) I don't know.

57. Which one of the following is the graph of $2x - 3 \geq 5$?

A) 

B) 

C) 

D) 

E) I don't know.

58. Which one of the following statements about the equation $2(x - 7) = 2x + 5$ is true?

A) The equation has no solution.

B) The equation has infinitely many solutions.

C) $x = 0$

D) $x = 19$

E) I don't know.

59. Find the value of x such that: $5x^2 + 15 = 95$

A) 4

B) -4

C) ± 4

D) All real numbers

E) I don't know.

60. In the rectangular solid below, the length of the diagonal PS is

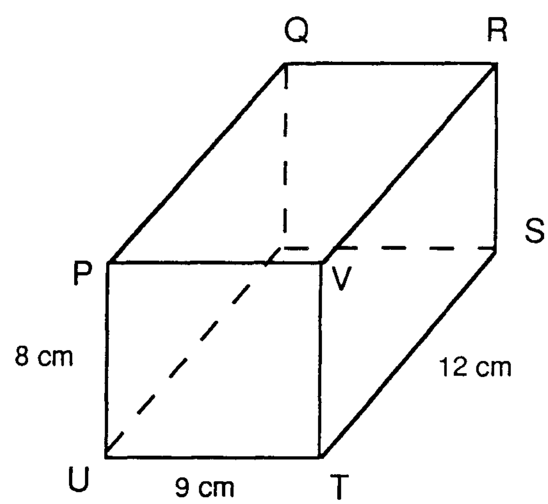
A) 21 cm

B) 17 cm

C) 20 cm

D) $\sqrt{200}$ cm

E) I don't know.



This the end of Part 3. Check your work
and hand in your booklet and answer sheet.

1990 BRITISH COLUMBIA MATHEMATICS ASSESSMENT

GRADE 10

FORM D

STUDENT FORM

BACKGROUND INFORMATION

For each item, shade in the appropriate space on the answer sheet.

1. Sex

   A) Male
   B) Female

2. Age

A)	14 or less	D)	17
B)	15	E)	18
C)	16	F)	19 or more

3. What program are you in?

   A) Regular program in English
   B) French Immersion
   C) Programme-cadre de français

4. What mathematics course are you currently taking (if you are not taking one this semester, which course did you take last semester)?

   A) Math 8
   B) Math 9
   C) Math 9A
   D) Math 10
   E) Math 10A
   F) Introductory Math 11
   G) Math 11A
   H) Math 11
   I) Algebra 11
   J) Algebra 12
   K) A mathematics course not on this list
   L) I am not taking a mathematics course this year.

5. Which of the following **best** describes the mathematics course you took or are taking this year?

   A) A ten-month course
   B) A semestered course beginning in September
   C) A semestered course beginning in January or February
   D) I am not taking a mathematics course this year.
   E) Other

6. What made you decide to take the mathematics course you are currently taking (or the one you took last semester)? **You may choose more than one response.**

   A) The counsellor suggested it.
   B) My parent(s) or guardian(s) suggested it.
   C) My last year's mathematics teacher suggested it.
   D) I decided on my own.
   E) I had no choice because of my marks in previous mathematics courses.
   F) It is required for the next mathematics course I want to take.
   G) Most of my friends take this course.
   H) I took the course because I am good at mathematics.
   I) Some other reason.

7. Which mathematics course(s) do you intend to take in both Grades 11 and 12? **Mark all that apply.**

   A) None
   B) Math 10
   C) Math 10A
   D) Math 11
   E) Introductory Math 11
   F) Math 11A
   G) Introductory Accounting 11
   H) Math 12
   I) Survey Math 12
   J) An enriched mathematics course (e.g. Advanced Placement, International Baccalaureate, Calculus, etc.)
   K) A mathematics course not on this list

8. What do you plan to do after leaving secondary school? **Choose one.**

   A) Attend a business school or technical college
   B) Attend a vocational, art, or trade training school
   C) Attend a community college: university transfer program
   D) Attend a community college: career program
   E) Attend university
   F) Look for a full-time job
   G) Take a year off and then return to school
   H) Take a year off and then look for a job
   I) Other plans
   J) Undecided

For the next three items, decide to what extent you agree or disagree.

9. You have to be able to do mathematics to get a good job.

A) Strongly Disagree
B) Disagree
C) Do not know
D) Agree
E) Strongly Agree

10. Most people use mathematics in their jobs.

A) Strongly Disagree
B) Disagree
C) Do not know
D) Agree
E) Strongly Agree

11. When I leave school, I would like a job where I have to use mathematics.

A) Strongly Disagree
B) Disagree
C) Do not know
D) Agree
E) Strongly Agree

For each of the next three items, three answers are needed.

A) Tell how important you think the topic is.
B) Tell how easy you think the topic is.
C) Tell how much you like the topic.

If you are not sure what a topic means, leave its three answers blank.

12. Geometry

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

13. Data Analysis

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

14. Working with decimals, fractions, and percent

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

For the next three items, think of your mathematics classes during a typical school week.

15. We use computers in our mathematics class.

A) Almost every period
B) Often
C) Sometimes
D) Rarely
E) Never

16. We have quizzes or tests in mathematics.

A) Almost every period
B) Often
C) Sometimes
D) Rarely
E) Never

17. We work in small groups in our mathematics class.

A) Almost every period
B) Often
C) Sometimes
D) Rarely
E) Never

ACHIEVEMENT SURVEY: Part 1, Items 1 - 20.

These items are to be answered by all students.

1. A used automobile can be bought for cash for $2850, or on credit with a down payment of $400 and $80 a month for three years. How much more would a person pay by buying on credit than by buying the car for cash?

A) $ 3280

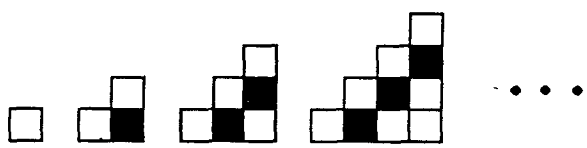
B) $ 640

C) $ 430

D) $ 400

E) I don't know.

2. How many white squares will there be in the 10th figure in the following pattern?



A) 45

B) 46

C) 55

D) 512

E) I don't know.

3. Which number is largest?

A) $\frac{2}{3}$

B) $\frac{4}{5}$

C) $\frac{3}{4}$

D) $\frac{5}{8}$

E) I don't know.

4. In a school election with three candidates, Mike received 120 votes, Lawrence received 30 votes, and Lesley received 50 votes. What percent of the total vote did Mike receive?

A) 30%

B) 40%

C) 60%

D) 120%

E) I don't know.

5. What is the mean of the following numbers?

2, 2, 2, 3, 4, 5, 10

A) 3

B) 2

C) 10

D) 4

E) I don't know.

6. How many passengers used the airport in June?

AIRLINE PASSENGERS FOR FIRST SIX MONTHS OF THE YEAR

Airports	Hundreds of Passengers per Month						Total
	Jan.	Feb.	Mar.	Apr.	May	June	
Bay City	9	3	5	7	2	4	30
Camden	6	8	1	5	8	2	30
Dover	8	5	9	6	6	3	37
Fiske	5	6	6	1	3	7	28
Grange	1	2	3	6	7	10	29
TOTAL	29	24	24	25	26	26	154

A) 7

B) 26

C) 700

D) 2600

E) I don't know.

7. A bag contains 3 red marbles, 2 white marbles, and 20 black marbles. What is the probability of randomly choosing a white marble?

A) 0.08

B) 0.5

C) 0.92

D) 2.0

E) I don't know.

8. Two dice are rolled. What is the probability of rolling a total of 5?

A) $\frac{1}{9}$

B) $\frac{5}{36}$

C) $\frac{1}{18}$

D) $\frac{2}{9}$

E) I don't know.

9. Which two angles are each supplementary to $\angle 4$?

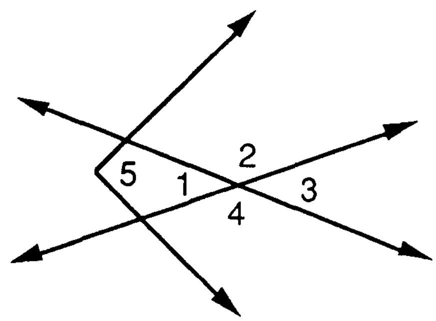
A) $\angle 1$ and $\angle 2$

B) $\angle 2$ and $\angle 3$

C) $\angle 5$ and $\angle 1$

D) $\angle 1$ and $\angle 3$

E) I don't know.



10. Δ ABC is a right triangle and ΔABD is equilateral. $\angle$ BDC =

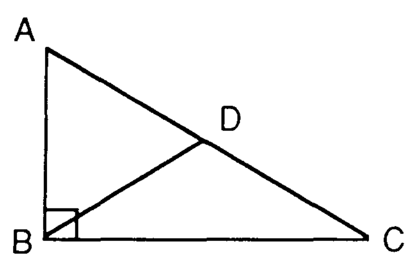
A) 90°

B) 120°

C) 135°

D) between 120° and 135°

E) I don't know.



11. When Joe walks from his house to Kelly's house, he follows the path through the open field. How far does he walk?

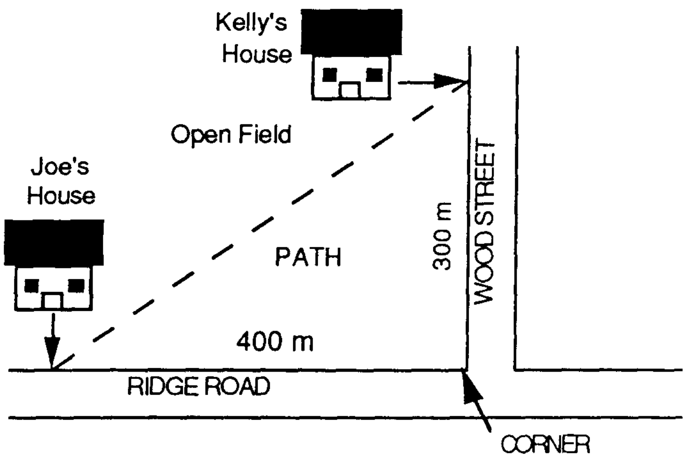
A) 450 m

B) 500 m

C) 550 m

D) 600 m

E) I don't know.



12. Δ RST and Δ RXY are right triangles. If RY = 4, XY = 3, and ST = 6, find RT.

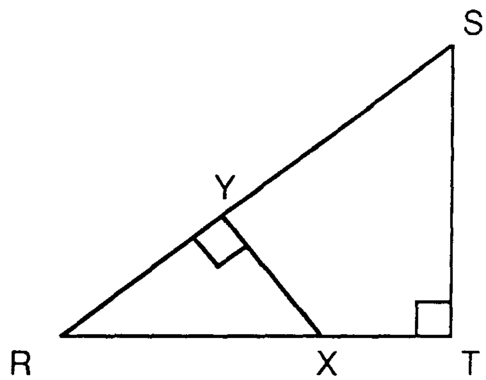
A) 7

B) 8

C) 10

D) 12

E) I don't know.



13. The best estimate for the area of the circle shown below is

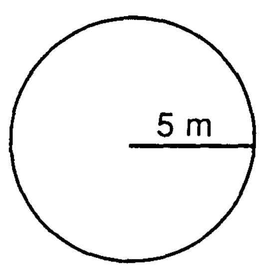
A) 15 m^2

B) 75 m^2

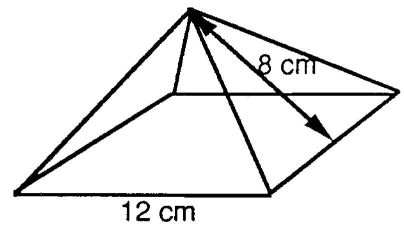
C) 100 m^2

D) 5 m^2

E) I don't know.



14. Find the surface area of the square pyramid shown below.
Surface Area = $b^2 + 4(\frac{1}{2}bh)$, where b is the length of the base and h is the slant height.



A) 192 cm^2

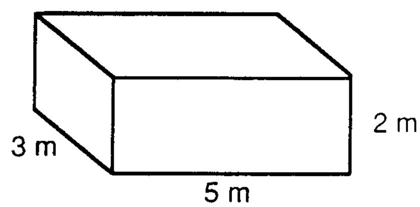
B) 144 cm^2

C) 336 cm^2

D) 384 cm^2

E) I don't know.

15. What is the surface area of the.rectangular prism shown below?
Surface Area = $2(lw + lh + wh)$



A) 30 m^2

B) 31 m^2

C) 60 m^2

D) 62 m^2

E) I don't know.

16. The best estimate for the volume of the solid shown below is

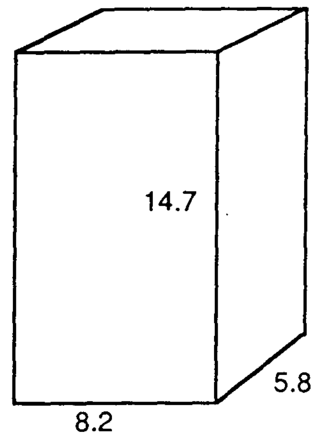
A) 29

B) 56

C) 550

D) 720

E) I don't know.



17. Simplify: $r + s - (r - s)$

A) 0

B) $2r + 2s$

C) $2r$

D) $2s$

E) I don't know.

18. Simplify: $(3p + 2q) - (p + q)$

A) $2p + q$

B) $2p + 3q$

C) $4p - 3q$

D) $4p - q$

E) I don't know.

19. If five is added to a certain number and the sum is multiplied by three, the result is −17. Find the number.

A) $-\frac{2}{3}$

B) -4

C) $-7\frac{1}{3}$

D) $-10\frac{2}{3}$

E) I don't know.

20. How high would a stack of one million pennies be?

A) 2 m

B) 200 m

C) 2 000 m

D) 20 000 m

E) I don't know.

This is the end of Part 1. Students who are currently taking Mathematics 10, or who did so last semester, go to Part 3 on page 21.
All others complete Part 2 beginning on the next page: Items 21 - 40.

ACHIEVEMENT SURVEY: PART 2, ITEMS 21-40

21. What is the value of $2^3 \times 3^2$?

A) 72

B) 36

C) 54

D) 48

E) I don't know.

22. Simplify: $10 + 35 \div 5 + 2$

A) 19

B) 11

C) 15

D) $6\frac{3}{7}$

E) I don't know.

23. Evaluate: $(2^2)^{-2}$

A) -16

B) 0

C) $\frac{1}{16}$

D) 16

E) I don't know.

24. Written as a decimal, 20% equals

A) 0.2

B) 0.02

C) 2.0

D) 20.0

E) I don't know.

25. Write $\frac{3}{8}$ as a decimal.

A) 0.3

B) 0.24

C) 0.375

D) $2.66\dot{6}$

E) I don't know.

26. The scientific notation for 634.78 is

A) $0.634\ 78 \times 10^{-3}$

B) 6.3478×10^{-2}

C) 63.478×10

D) 6.3478×10^{2}

E) I don't know.

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27. A marathon runner covers 42 km in $2\frac{1}{2}$ hours. His average speed is

A) 8.4 km/h

B) 16.8 km/h

C) 25.2 km/h

D) 33.6 km/h

E) I don't know.

28. The sales tax is 5%. How much would the sales tax be on a new car that costs $6750.00?

A) $675.00

B) $337.50

C) $67.50

D) $33.75

E) I don't know.

29. Find the missing term: $\frac{2}{a} = 1\frac{1}{3}$

A) $\frac{3}{2}$

B) $\frac{8}{3}$

C) 3

D) 6

E) I don't know.

30. A team scored an average of 3 points per game for 5 games. How many points altogether were scored in the 5 games?

A) 5

B) 15

C) 25

D) 75

E) I don't know.

31. The distance travelled by two cars during a period of four hours is shown in the graph below. Three hours after starting, how many kilometres is car A ahead of car B?

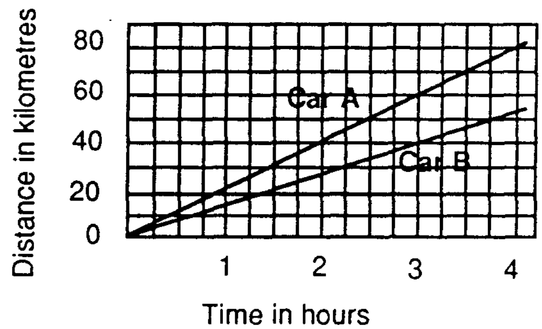
A) 2

B) 10

C) 15

D) 20

E) I don't know.



32. The graph shows the distance travelled by a tractor during a period of four hours. How fast is the tractor moving?

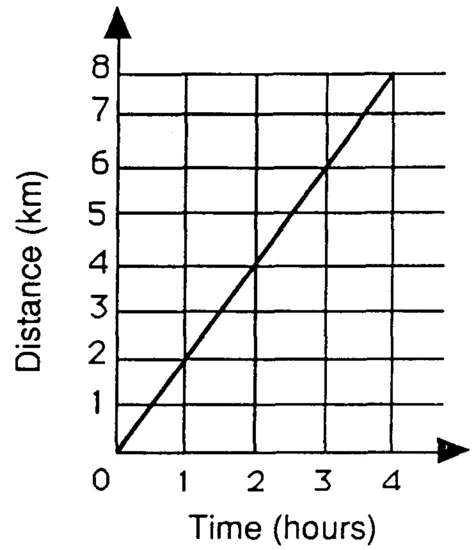
A) 1 km/h

B) 2 km/h

C) 4 km/h

D) 8 km/h

E) I don't know.



33. The coordinates of point Q are

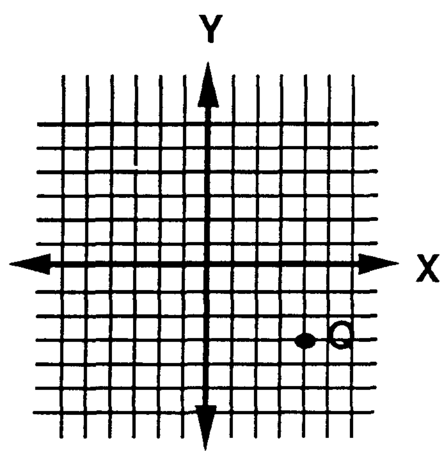
A) (− 4, 3)

B) (− 3, 4)

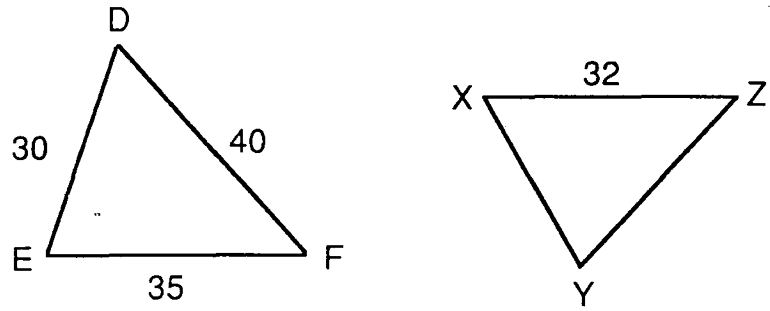
C) (3, − 4)

D) (4, − 3)

E) I don't know.



34. Δ DEF is similar to Δ XYZ. Find the length of YZ.



A) 26.25

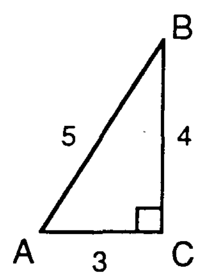
B) 28

C) $37.\dot{3}$

D) 43.75

E) I don't know.

35. The tangent of $\angle$ A in the figure is equal to



A) $\frac{4}{5}$

B) $\frac{5}{4}$

C) $\frac{3}{4}$

D) $\frac{4}{3}$

E) I don't know.

36. Δ ABC is a right triangle. If $\angle A = 40°$ and AC = 10, find BC.

$\sin 40° = 0.6428$
$\cos 40° = 0.7660$
$\tan 40° = 0.8391$

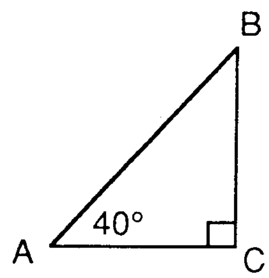
A) 11.917

B) 6.428

C) 8.391

D) 0.08391

E) I don't know.



37. The area of this figure is

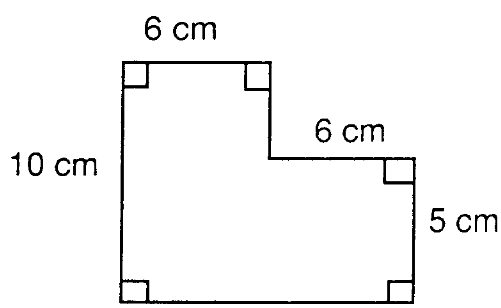
A) 39 cm^2

B) 44 cm^2

C) 90 cm^2

D) 120 cm^2

E) I don't know.



38. The volume of the rectangular prism below is 576 cm^3. What is its height?

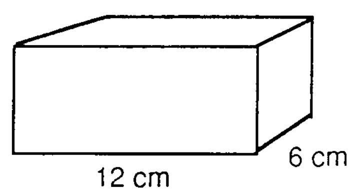
A) 4 cm

B) 8 cm

C) 16 cm

D) 32 cm

E) I don't know.



39. Evaluate: $-4a(a-3b)$ when $a = 2$ and $b = -1$

A) -40

B) -8

C) 8

D) 40

E) I don't know.

40. Solve for n: $4(n-3) - 5 = 7n$

A) $n = \frac{-17}{3}$

B) $n = \frac{17}{3}$

C) $n = \frac{7}{3}$

D) $n = \frac{-7}{3}$

E) I don't know.

This is the end of Part 2. Check your work
and hand in your booklet and answer sheet.

ACHIEVEMENT SURVEY: PART 3, ITEMS 41-60

This section is for students who are taking Math 10 now,
or who took Math 10 last semester.

41. Write in simplest radical form.

$$3\sqrt{48}$$

A) $12\sqrt{3}$

B) $7\sqrt{3}$

C) $6\sqrt{12}$

D) $5\sqrt{12}$

E) I don't know.

42. Find the quotient in simplest radical form.

$$\frac{6\sqrt{20}}{2\sqrt{10}}$$

A) $4\sqrt{10}$

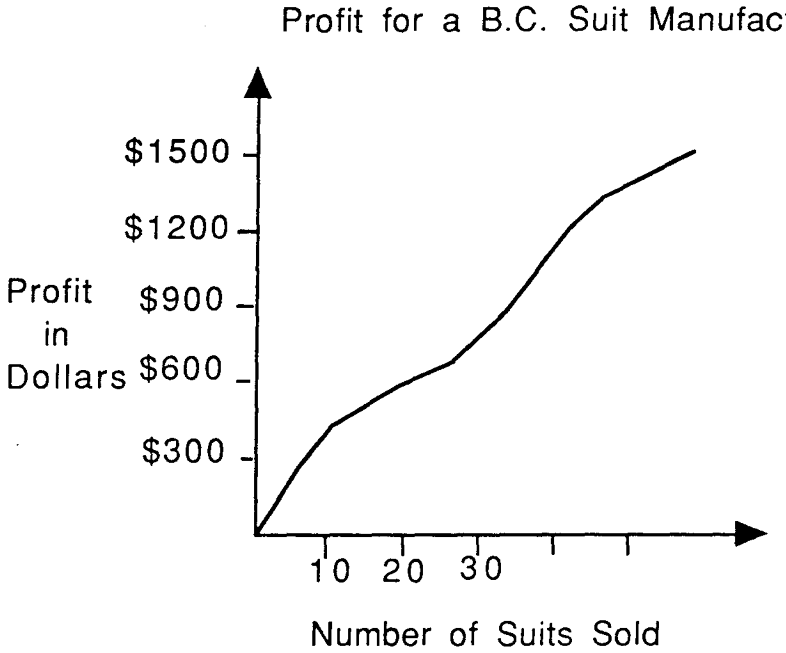
B) $3\sqrt{2}$

C) $4\sqrt{2}$

D) $3\sqrt{10}$

E) I don't know.

43. If the relationship shown in the graph below continues between profit and the number of suits sold, what will be the approximate profit for the sale of 35 suits?



A) $600

B) $900

C) $1200

D) $1500

E) I don't know.

44. A collection of coins consists of 5 quarters, 2 dimes, 6 pennies, 3 nickels, and 4 one-dollar coins. What is the likelihood that if one is drawn at random, it will be a nickel?

A) 15%

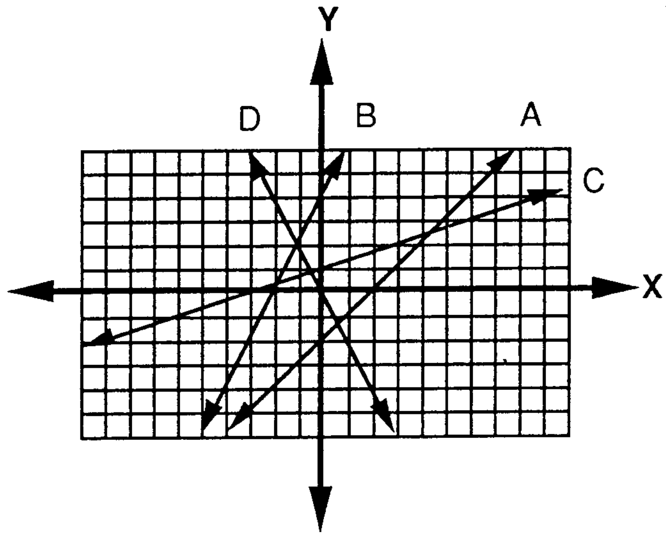
B) 12%

C) 25%

D) 10%

E) I don't know.

45. Which line is the graph of the equation $2x - y = -4$?



A) A

B) B

C) C

D) D

E) I don't know.

46. Which one of the following equations is satisfied by both of the ordered pairs (3, −1) and (10, − 4)?

A) $3x - 7y = 2$

B) $-3x + 7y = 2$

C) $y = \frac{-3}{7}x + \frac{2}{7}$

D) $y = \frac{-7}{3}x + \frac{2}{3}$

E) I don't know.

47. Quadrilateral ABDC is made up of 2 equilateral triangles ABC and BCD. The measure of $\angle ABD$ is

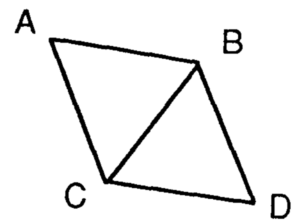
A) 60°

B) 90°

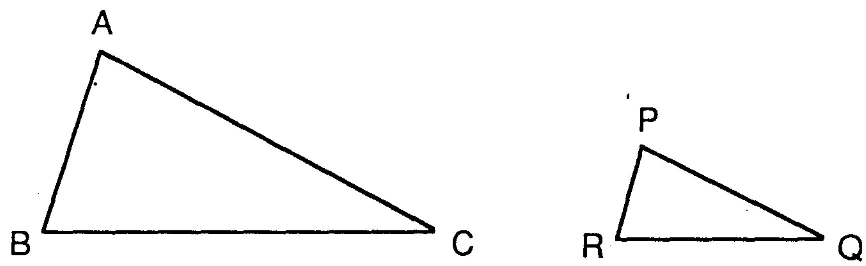
C) 120°

D) 150°

E) I don't know.



48. If ΔABC is similar to ΔPRQ, which one of the following is true?



A) $\frac{AB}{BC} = \frac{PQ}{QP}$

B) $\frac{AB}{PQ} = \frac{PR}{AC}$

C) $\frac{PR}{QR} = \frac{AC}{BC}$

D) $\frac{AB}{AC} = \frac{PR}{PQ}$

E) I don't know.

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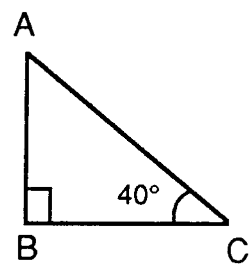
49. In the right triangle below $\angle C = 40°$ and $BC = 20.0$. Use the following information to find AB.

$$\sin 40° = 0.6428$$
$$\cos 40° = 0.7660$$
$$\tan 40° = 0.8391$$



A) 16.8

B) 15.3

C) 12.9

D) 23.8

E) I don't know.

50. If $x > 0$ and $y < 0$, then the point (x, y) is located in quadrant

A) I

B) II

C) III

D) IV

E) I don't know.

51. In triangle PQR, ST will be parallel to RQ if

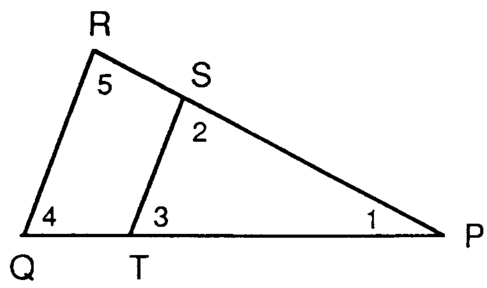
A) $\angle 1 + \angle 2 + \angle 3 = 180°$

B) $\angle 2 + \angle 5 = 180°$

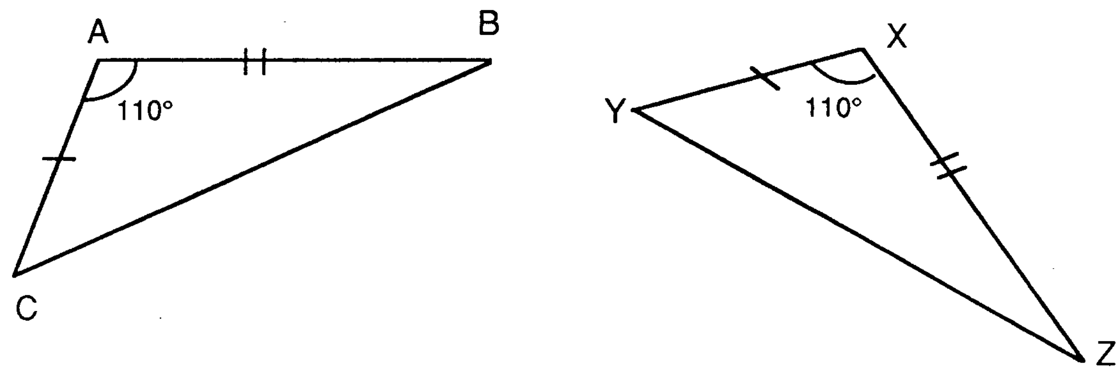
C) $\angle 3 = \angle 4$

D) $\angle 4 = \angle 2$

E) I don't know.



52. In the figures below AB = XZ, AC = XY, and $\angle$ CAB and $\angle$ YXZ each measure 110°. Are the triangles congruent? If so, choose the answer that tells you this.



A) Yes (S-S-S)

B) Yes (A-S-A)

C) No

D) Yes (S-A-S)

E) I don't know.

53. Simplify: $15p^6 \div 3p^2$

A) $5p^3$

B) $5p^4$

C) $12p^3$

D) $12p^4$

E) I don't know.

54. If $\sqrt{a} = 0.9z^4$, then a =

A) $0.3z^2$

B) $0.81z^2$

C) $0.32z^6$

D) $0.81z^8$

E) I don't know.

55. Simplify: $\sqrt{\dfrac{0.0049x^8}{y^6}}$

A) $0.7x^4y^3$

B) $0.07x^4y^3$

C) $\dfrac{0.07x^4}{y^3}$

D) $\dfrac{0.007x^4}{y^3}$

E) I don't know.

56. $R = \frac{1}{x} + \frac{1}{y}$. If x = 2 and y = 3, then the value of R is

A) $\frac{1}{6}$

B) $\frac{1}{5}$

C) $\frac{2}{5}$

D) $\frac{5}{6}$

E) I don't know.

57. Solve for x: $5x - 15x + 6 \leq 16$

A) $x \leq 1$

B) $x \geq 1$

C) $x \leq -1$

D) $x \geq -1$

E) I don't know.

58. Solve for x: $x + 3 = \frac{1}{2}x - 1$

A) $x = -8$

B) $x = -\frac{8}{3}$

C) $x = 4$

D) $x = 8$

E) I don't know.

59. Solve the following equation for m: $y = mx + b$

A) $m = y - b - x$

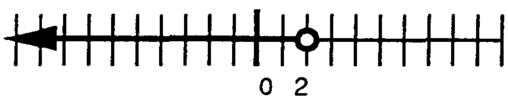
B) $m = \dfrac{y - b}{x}$

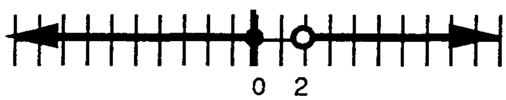
C) $m = y + b - x$

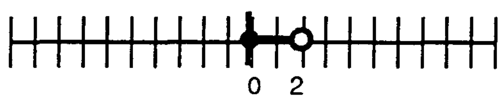
D) $m = \dfrac{1}{x}(b - y)$

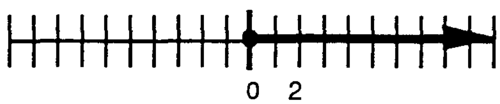
E) I don't know.

60. The graph of $x \leq 0$ or $x > 2$ is

A) 

B) 

C) 

D) 

E) I don't know.

This is the end of Part 3. Check your work and hand in your booklet and answer sheet.

1990
BRITISH COLUMBIA MATHEMATICS ASSESSMENT

GRADE 7

FORM A

STUDENT FORM

BACKGROUND INFORMATION

For each item, shade in the appropriate space on the answer sheet.

1. Sex

   A) Male
   B) Female

2. Age

   A) 10 or less
   B) 11
   C) 12
   D) 13
   E) 14 or more

3. What program are you in?

   A) Regular Grade 7 program in English
   B) Early French Immersion
   C) Late French Immersion
   D) Programme-cadre de français

4. In this class, mathematics is taught in

   A) English.
   B) French.

For the next three items, decide to what extent you agree or disagree.

5. You have to be able to do mathematics to get a good job when you grow up.

   A) Strongly Disagree
   B) Disagree
   C) Do not know
   D) Agree
   E) Strongly Agree

6. Most people use mathematics in their jobs.

   A) Strongly Disagree
   B) Disagree
   C) Do not know
   D) Agree
   E) Strongly Agree

7. When I leave school, I would like a job where I have to use mathematics.

   A) Strongly Disagree
   B) Disagree
   C) Do not know
   D) Agree
   E) Strongly Agree

For each of the next four items, three answers are needed.

A) Tell how important you think the topic is.
B) Tell how easy you think the topic is.
C) Tell how much you like the topic.

If you are not sure what a topic means, leave its three answers blank.

8. Learning geometry

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

9. Working with data and graphs

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

10. Learning to use calculators

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

11. Learning strategies for problem solving like looking for patterns and making models

A	B	C
not at all important	very difficult	dislike a lot
not important	difficult	dislike
undecided	undecided	undecided
important	easy	like
very important	very easy	like a lot

For the next three items, think of your mathematics classes during a typical school week.

12. We use computers in our mathematics class.

A) Almost every day
B) Often
C) Sometimes
D) Rarely
E) Never

13. The teacher helps individual students.

A) Almost every day
B) Often
C) Sometimes
D) Rarely
E) Never

14. We review our homework and discuss solutions.

A) Almost every day
B) Often
C) Sometimes
D) Rarely
E) Never

Use this page for your rough work.

ACHIEVEMENT SURVEY

1. Subtract: $\begin{array}{r} 2008 \\ \underline{-\ 189} \end{array}$

   A) 819

   B) 1181

   C) 1819

   D) 2181

   E) I don't know.

2. As of June 1, 1976, the population of Canada was 22 589 416. Round off 22 589 416 to the nearest ten thousand.

   A) 22 580 000

   B) 23 000 000

   C) 22 600 000

   D) 22 590 000

   E) I don't know.

3. Meg wants to mail party invitations to 36 friends. Envelopes are only sold in packets of 15 and cost 75¢ per packet. How much will she have to spend for envelopes?

   A) \$1.50

   B) \$1.80

   C) \$2.25

   D) \$2.70

   E) I don't know.

4. The value of 3 + 4(5 + 2) is

A) 25

B) 26

C) 31

D) 49

E) I don't know.

5. **Estimate** the product: 9.785 x 11.134 x 2.9065 x 8.910

A) 3000

B) 2000

C) 300

D) 200

E) I don't know.

6. Write $\frac{8}{12}$ in lowest terms.

A) $\frac{3}{4}$

B) $\frac{2}{3}$

C) $1\frac{1}{2}$

D) $1\frac{1}{3}$

E) I don't know.

7. Which one of the following numbers is largest?

   A) 0.694

   B) 0.07

   C) 0.76

   D) 0.0816

   E) I don't know.

8. Dividing by 1000 is the same as multiplying by which one of the following?

   A) 0.01

   B) 0.001

   C) 0.000 1

   D) 0.000 01

   E) I don't know.

9. John had 12 baseball cards. He gave $\frac{1}{3}$ of them to Jim. How many does John have left?

   A) 4

   B) 6

   C) 8

   D) 9

   E) I don't know.

10. Each of the students in the drama club ate $\frac{2}{3}$ of a pizza at the year-end party. If they ate 12 pizzas in total, how many students are there in the club?

A) 8

B) 18

C) 24

D) 36

E) I don't know.

11. Which one of the following is equivalent to 2 : 3 ?

A) 3 : 4

B) 5 : 12

C) 3 : 2

D) 4 : 6

E) I don't know.

12. A machine seals 225 boxes in 3 hours. There are 1000 boxes to seal. How many will be left unsealed after an 8-hour shift?

A) 400

B) 600

C) 800

D) 925

E) I don't know.

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13. There are 140 players in a tournament. The ratio of girls to boys is 3 : 4. How many girls are there?

A) 40

B) 60

C) 80

D) 105

E) I don't know.

14. Write 45% as a fraction in lowest terms.

A) $\frac{1}{45}$

B) $\frac{4}{5}$

C) $\frac{1}{5}$

D) $\frac{9}{20}$

E) I don't know.

15. Which one of the following shows a discount of 10%?

A) 30¢ off $3.00

B) 35¢ off $3.00

C) 40¢ off $3.00

D) 45¢ off $3.00

E) I don't know.

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16. What is the opposite of −2?

A) $\frac{-1}{2}$

B) $\frac{1}{2}$

C) 0

D) 2

E) I don't know.

17. When a positive number is divided by a negative number, the answer is

A) positive.

B) negative.

C) zero.

D) You can't tell without knowing what the numbers are.

E) I don't know.

18. Which of the following statements is **false**?

A) Zero is smaller than any positive number.

B) All positive numbers are larger than zero.

C) All positive numbers are larger than all negative numbers.

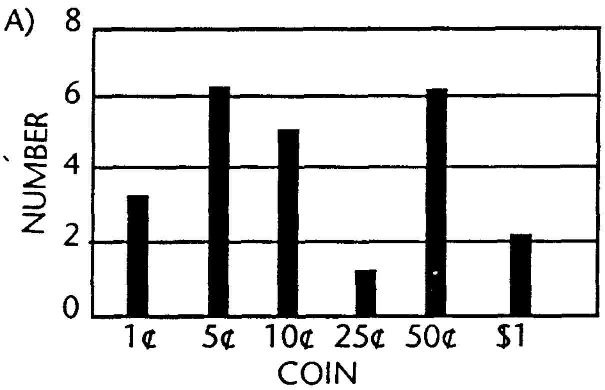
D) Zero is smaller than any negative number.

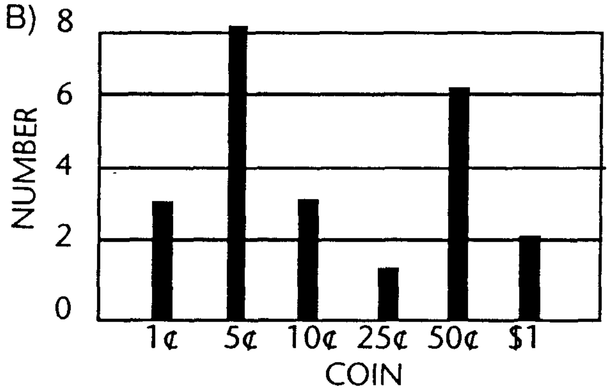
E) I don't know.

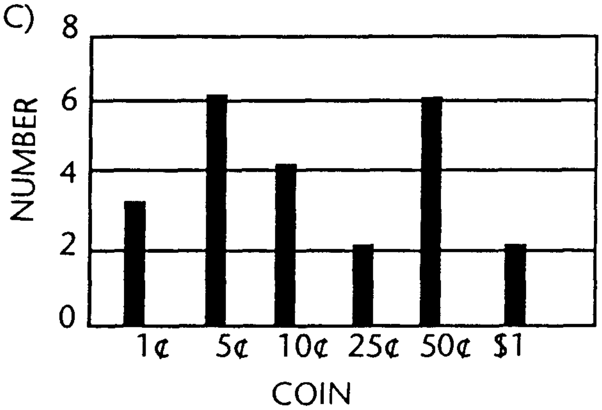
19. The table shows the numbers of various coins found in a box.

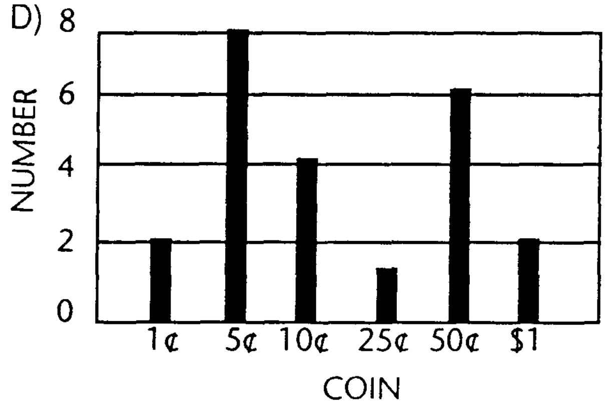
Coin	Number found
$1 (dollar coin)	2
50¢ (fifty-cent piece)	6
25¢ (quarter)	1
10¢ (dime)	3
5¢ (nickel)	8
1¢ (penny)	3

Which one of the following graphs shows this?

A) 

B) 

C) 

D) 

E) I don't know.

20. About how many is a million?

A) The number of hairs on your head

B) The number of grains of sand on a beach

C) The number of people that could be packed onto a soccer field standing up

D) The number of tennis balls needed to fill a classroom

E) I don't know.

21. For a party game each number shown below was painted on a different ping pong ball, and the balls were thoroughly mixed up in a bowl. If a ball is picked from the bowl by a blindfolded person, what is the probability that the ball will have a 4 on it?

2, 3, 4, 4, 5, 6, 8, 8, 9, 10

A) $\frac{1}{2}$

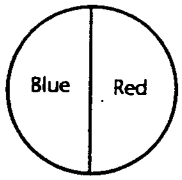
B) $\frac{1}{4}$

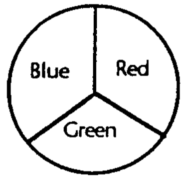
C) $\frac{1}{5}$

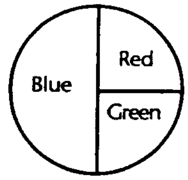
D) $\frac{1}{10}$

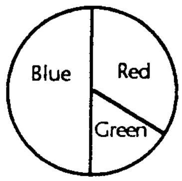
E) I don't know.

22. What spinner would you use to conduct a probability experiment on your friends' favourite colours if half of them prefer blue, a third of them prefer red, and the rest like green?

A) 

B) 

C) 

D) 

E) I don't know.

23. Two plastic discs are tossed in the air and, when they land, the numbers that show are added together. One of the discs has 1 on one side and 2 on the other. The second disc has 3 on one side and 4 on the other. What sums are possible?

A) 5 only

B) 1, 2, 3, and 4

C) 4, 5, and 6

D) 1, 2, 3, 4, 5, and 6

E) I don't know.

24. To find out how much time Grade 7 students spend watching TV, whom should you ask?

A) Your friends

B) The parents of Grade 7 students

C) Grade 7 students

D) Students in the school

E) I don't know.

25. Which one of the following names does **not** read the same if written on a card and held up to a mirror?

A) AVA

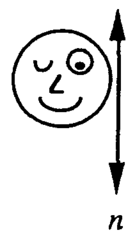
B) EVE

C) MOM

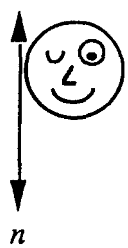
D) OTTO

E) I don't know.

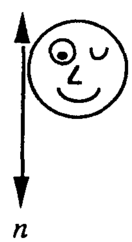
26. Which one of the following diagrams shows the reflection of the face in the line n?



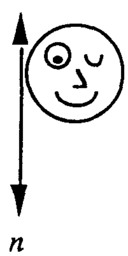
A)



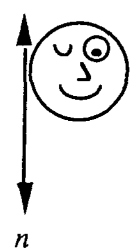
B)



C)



D)



E) I don't know.

27. Angle A and Angle B are congruent. If Angle A has a measure of 35°, what is the measure of Angle B?

A) 35°

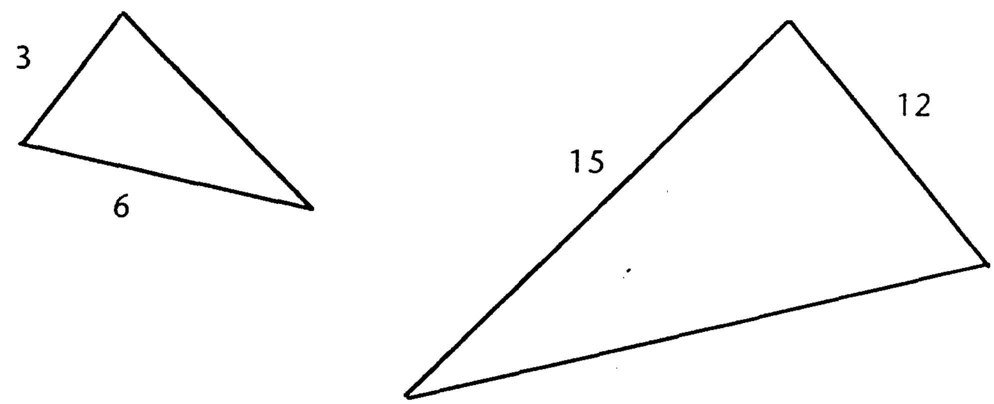
B) 55°

C) 145°

D) 325°

E) I don't know.

28. The two triangles shown below are similar. What is the missing length on the large triangle?



A) $3\frac{3}{4}$

B) $7\frac{1}{2}$

C) 24

D) 30

E) I don't know.

29. With 4 toothpicks you can make 1 small square. With 7 toothpicks you can make 2 small squares, and with 10 toothpicks you can make 3 small squares. What is the largest number of small squares that you can construct with 34 toothpicks?

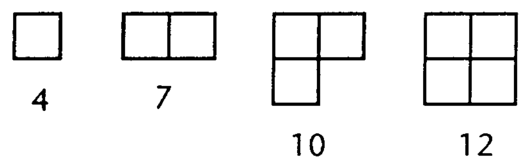
A) 10

B) 12

C) 13

D) 16

E) I don't know.



30. Which point has the coordinates (2, 3)?

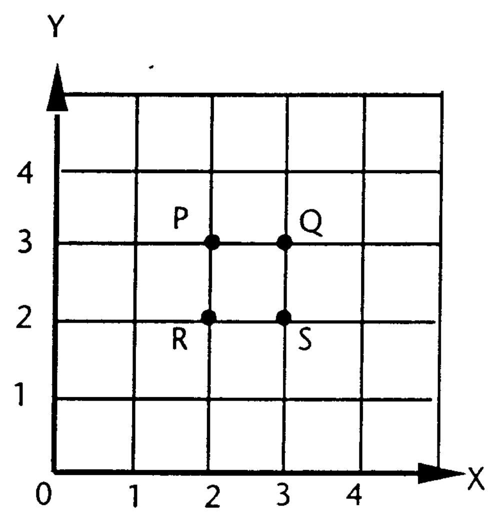
A) P

B) Q

C) R

D) S

E) I don't know.



31. A graduated cylinder contains 500 mL of water. A rock is placed in the cylinder and the water level rises to 683 mL. What is the volume of the rock?

A) 183 cm^3

B) 317 cm^3

C) 683 cm^3

D) 1183 cm^3

E) I don't know.

32. The excavation for a swimming pool is a rectangular hole that is 10 m long, 3 m wide, and 3 m deep. A dumptruck can carry 12 m^3 of fill. How many truckloads did it take to remove the fill from the excavation?

A) 3

B) 7

C) 8

D) 12

E) I don't know.

33. 250 g is how many kilograms?

A) 25

B) 250

C) 0.25

D) 2.5

E) I don't know.

34. Daley's Fruit Stand is on the highway 400 m west of Ash Street. Poplar Street is 1.2 km east of Ash Street along the highway. How far is Daley's Fruit Stand from Poplar Street?

A) 401.2 m

B) 520 m

C) 1.6 km

D) 5.2 km

E) I don't know.

35. A small car has a fuel tank that holds 35 L of gas. The car consumes 7.5 L for each 100 km driven. If a trip is 250 km, how much gas remains if the trip was started with a full tank?

A) 16.25 L

B) 18.75 L

C) 53.75 L

D) 1840 L

E) I don't know.

36. Which one of the following stands for the product of a number and 6?

A) $y + 6$

B) $y - 6$

C) $6y$

D) $\frac{y}{6}$

E) I don't know.

37. Of the following expressions, which one represents a number n increased by 5?

A) $5 - n$

B) $n + 5$

C) $5 < n$

D) $\frac{5}{n}$

E) I don't know.

38. Gary works G hours for $7 per hour and Andy works A hours for $5 per hour. What is the total amount of money that they are paid?

A) 7A + 5G

B) 12(A + G)

C) 12AG

D) 7G + 5A

E) I don't know.

39. When the input is x the output is

INPUT	OUTPUT
3	7
4	9
5	11
6	13
7	15
8	17
.	.
.	.
.	.
x	__

A) 19

B) 2x – 1

C) 2x + 1

D) x

E) I don't know.

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40. Solve: $\frac{x}{8} = 16$

A) 2

B) 8

C) 24

D) 128

E) I don't know.