A Longitudinal Study of the Relationship Between Mathematics Achievement and Mathematics Anxiety from Years 6 to 10

by

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ABSTRACT.

MATHEMATICS ANXIETY AND MATHEMATICS ACHIEVEMENT OF STUDENTS IN YEARS 6 TO 10.

This study had three objectives:

To establish that mathematics anxiety was being experienced by students in years 6 through to 10, to determine that a negative correlation existed between anxiety and achievement at each year level and that this correlation was of moderate to strong influence and to determine the direction of causation between anxiety and achievement. That is, does an increase in the level of anxiety cause a decrease in the level of achievement or does a lack of achievement cause an increase in anxiety.

The reasoning behind the research questions took into account the works of Spence, Sarason, Spielberger, Yerkes and Dodson, Ames and the critique by Rogosa of cross-lagged panel analysis.

Three schools were used in the study – a girls' school, a boys' school and a co-educational school. Statistics were calculated using the SPSSX

programme and Microsoft Excel. The preponderance of causation was determined using a form of cross-lagged panel analysis based on Rogosa's Structural Regression model.

Mathematics anxiety was found to exist at year 6 level through to year 10 level. The degree of anxiety was moderate to strong and at a significant level throughout. The preponderance of causation was found to be in the direction of changes in achievement causing changes in anxiety.

The results were strong and significant throughout, indicating that the direction of causation was unambiguous (the probability of cross-lagged panel results happening by chance alone was 0.0006). It was determined that a negative correlation existed between anxiety and achievement, hence any increase in the level of achievement would result in a decline in the level of anxiety, and any decrease in achievement would cause an increase in the level of anxiety experienced by the students.

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For his willing and generous assistance with the computerization of tables and diagrams I thank Mr. Alan Jones.

My wife, Carlene, proof read the final draft of the study. I thank her sincerely. I thank her also for her encouragement and understanding.

Declaration

I certify that this thesis does not include any material previously submitted for a degree or diploma in any University. Moreover, to the best of my knowledge it does not contain any material previously written or published by another person unless duly acknowledged.

I consent to the thesis being made available for photocopying and loan if accepted for the award of the degree.

David P. Wither

20th May, 1998.

A LONGITUDINAL STUDY OF THE RELATIONSHIP

BETWEEN

MATHEMATICS ACHIEVEMENT

AND

MATHEMATICS ANXIETY

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Chapter 1.

Introduction.

The amount of research in Australia into the relationship and correlation between achievement in mathematics and anxiety towards mathematics has been relatively sparse. Of the research carried out here and abroad, the researchers have concentrated their efforts, in the main, at first year university level and beyond.

This study was designed to examine the relationship between mathematics achievement and mathematics anxiety in a sample of South Australian school students, aged between ten and fourteen, as they progressed from year six in the primary school to year ten in the secondary school.

Two aspects in particular were considered with respect to mathematics achievement and mathematics anxiety ~ (a) the correlation between the two variables, and (b) whether change in achievement caused a change in anxiety or a change in anxiety caused a change in achievement.

The study began with a pilot study the main aims of which were to ascertain whether mathematics anxiety did exist at year six of primary schooling, and if it did exist, whether the relationship between anxiety and achievement was negative and moderate to strong ($r \geq 0.3$) and significant at this level. The major part of the study was a longitudinal one, carried out over a period of five years during which time the students participating in the programme were given ten mathematics achievement tests and ten mathematics anxiety scales. A different achievement test was administered during each semester and a new anxiety scale administered during each year from year six to year ten.

The year six students participating in the pilot project came from five different schools. The schools were selected from different socioeconomic areas within the metropolitan area of Adelaide. The students participating in the main study attended three Adelaide metropolitan schools - one boys' school, one girls' school and one coeducational school. All were private schools, with a middle and upper class community of students. There was no overlap of students between the pilot study and the main study. The Australian Council for Educational Research initially developed the mathematics achievement tests used in the project. Those used during years eight, nine and ten were developed *ab initio* by the author. The anxiety scales were also developed and validated by the author.

Each of the questions in the six mathematical achievement tests developed by the author, was checked by the teachers of the participating schools for clarity, precision of wording, and applicability of content with respect to each specific area or topic of mathematics. Every care was taken to ensure that each problem was unambiguous. The design of the tests followed the same format as the ones which were administered to the students in years six and seven and published by the Australian Council of Educational Research.

The statements in each of the mathematics anxiety scales related to concepts and examples of mathematics as laid down in the mathematics syllabus for each of the years six through to ten. No example or concept was included which had not been taught to the students in all of the schools participating in the main study. The format was identical to the mathematics anxiety scale developed by the author (Wither,1987) and the scale developed by Rounds and Hendel (1980).

The correlations between mathematics achievement and mathematics anxiety were calculated after each period of testing. These calculations were carried out not only for the entire group of students but also subdivided to provide correlations for single gender grouping i.e. male students and female students and individual school groupings. The examination of the correlations for these six groups determined whether the relationship between achievement and anxiety was weak or strong, significant or not significant, at each semester during the five-year study.

Any correlation that seemed to be abnormal compared with the correlations of the other groups during each semester was further examined in order to find an explanation for the distortion of that particular correlation.

Panel analysis of the correlations over the five-year period was carried out using a Structured Regression model to ascertain whether or not a causal relationship existed between mathematics anxiety and mathematics achievement. Results were obtained for the entire group of students, the male student sample and the female student sample.

A review of the literature of recent and current research being carried out in the fields of anxiety, mathematics anxiety and mathematics achievement is also included in this study. Included in the review will be a summary of the research appertaining to students as they progress from primary school through secondary school to a tertiary institution. Also included in the thesis is a chapter describing in detail a number of research projects that are concerned with anxiety in general and mathematics anxiety in particular.

The concluding chapters summarise the findings of the longitudinal study and draw implications for the teaching of mathematics as a result of the study. Specific areas will be recommended in which future research may be carried out and proposals will be put forward as to how a greater level of achievement in the field of mathematics may be attained by students as they progress from year 6 to year 10.

Chapter 2

Literature Review.

Anxiety

A person's anxiety level can be inferred in a variety of ways. It can be manifested by the inability to marshal thoughts or excessive shaking or trembling. Other signs also indicating the presence of anxiety may include restlessness, tenseness of posture, an increased rate of speech and a general tendency to be easily distracted. Thus it can be seen that the nature of anxiety is very complex and there is no single definition of the psychological construct known as anxiety.

Kagan and Havemann (1976) in their description of anxiety determined that:

> *Anxiety is a vague, unpleasant feeling accompanied by a premonition that something undesirable is about to happen. (p.295)*

It appears that there are four situations that are likely to produce anxiety. Firstly, *when we encounter some unpleasant event that we cannot* *immediately understand*; for example, the experience that a new student has on arriving at a new school in a strange city or suburb.

Secondly, *when we are faced with events that are unpredictable*; for example when we are about to sit for a difficult test or attend an interview for a new job.

Thirdly, *when we sense a conflict between our thoughts and our behaviour;* for example when we do something that we have been taught is wrong.

Fourthly, *when we have two conflicting opinions* - we feel strongly about dedicating our lives to serving others, yet at the same time have a strong desire to earn a lot of money. (Kagan and Havemann ,1976, p296).

One word that can be applied to all four of these common sources of anxiety is **uncertainty**. The amount of anxiety a person feels when trying to learn something depends on how difficult the material is. (O'Neil et al, 1969).

It is also known that some people are more likely than others to suffer from anxiety in general or to be especially anxious in learning situations. In general these high anxiety students do better at learning simple tasks but are under a handicap when trying to learn more difficult materials. (Taylor, 1951; Farber and Spence 1953; O'Neil et al, 1969).

Atkinson et al (1960) found that people who are highly anxious about success and/or failure tend to adopt either a very conservative or a very risky strategy in life situations. They are inclined to settle for the *sure thing*, and thus avoid failure that would add to their anxiety, or else they tend to take the kind of chances at which success is such a remote possibility that failure can easily be excused. Less anxious people on the other hand, appear to have sufficient confidence to assume the middle range risks that are most likely to lead to success on the long term.

Along similar lines, Atkinson et al (1960) observed that college students who appear to have a high amount of fear of failure tend to leave examination rooms early, as if to avoid the further anxiety of continuing to try in the examination. This strategy, of course, only increases the likelihood of the failure that they found such a disturbing prospect.

That anxiety arousal is associated with decrements in academic performance is incontestable. From the time of the earliest work on this problem, Yerkes and Dodson (1908), to the present day, researchers have consistently reported a negative correlation between virtually every aspect of school achievement and a wide range of anxiety measures. (Tryon 1980, Wine 1980; Wither, 1987).

The late Kenneth W. Spence of the University of Iowa conceived anxiety to be " *an acquired drive that has the capacity to generally energize the organism.*" (Spence, 1960; Spence and Spence, 1966). Spence developed two constructs, which he believed played important roles in the processes of learning and performance. The first construct, called ***Habit ~ Strength*** (H) refers to one's existing tendency to respond to a particular situation. In Spence's terminology, a person who responds correctly to various situations has a high habit strength and that person's response is high in the response hierarchy. Similarly, a person giving incorrect associations has a low habit strength and his or her response is low in the response hierarchy. Thus a person making the incorrect association more often than making the correct association may develop anxiety towards such situations in which a choice has to be made, knowing that, if past experience is taken into consideration, the incorrect response is likely to be made.

The second construct of Spence is a motivational one, called ***Drive*** (D) and it has the capacity to activate the behaviour of the learner. In his study with animals, Spence defined drive in terms of hours of food or water deprivation, or the strength of an electric shock. The effects of the Drive construct on performance will depend on the degree of difficulty of the task. In a simple task where the correct response is dominant, high drive will facilitate performance; in the more complex situation in which incorrect answers are stronger than the correct response, high drive will impair performance.

People differ markedly in their tendency to react to stress. Some people overreact and hence tend to seek quietness and solitude in order to work comfortably; others need stimulation in order to work comfortably. Some students are quite distressed by being asked a question in public, while others actively seek the limelight. Thus stress in itself is neither good nor bad. A variety of factors determine whether the stress is eu-stress (from the Greek word meaning good) in which case the person will be challenged and invigorated by stress, or di-stress which means exactly what it says.

When anxiety is associated with a particular set of circumstances, we speak of state anxiety. Testing is a particularly common example. During such times state anxiety is aroused in some students because their competence is laid on the line, for example, by questioning in class or by formal testing. They may not, however, be more anxious than any one else in other, non-testing situations. Thus test anxiety is associated with anxiety about performing poorly when being evaluated. (Sarason et al, 1960).

The anxiety theory of the Yale theorists, (Mandler and Sarason 1952; Sarason et al, 1960; Sarason et al, 1975), hypothesizes that anxiety is largely determined by the nature of the situation interacting with the personal characteristics of the individual. These characteristics, which are developed over time, are methods of reacting to anxiety. They may be ***task relevant*** or ***task irrelevant*** depending on the nature of the task and the manner in which the individual perceives the learning situation, and these characteristic factors are of much greater importance than the level of simplicity or difficulty of the task.

Anxiety responses - unpleasant subjective feelings of apprehension, worry and tensions, are often accompanied by physiological adjustment. These physiological adjustments, which may include increased heart beat rate, and interference with gastro intestinal functioning - act to signal impending danger, and in turn, trigger other responses which serve to reduce feelings of anxiety. Task irrelevant responses are those that are directed towards a defence against the anxiety stimulus and are aimed at the avoidance of failure and the preservation of self-esteem. As such they are said to be self-centred rather than task oriented. They prevent a dispassionate assessment of the task because the individual is more aware of his responses than he is of the external stimulus situation. They are more likely to be aroused in high anxiety individuals who have developed a strong tendency to react this way in evaluative situations; and they interfere with ongoing task performance. The Yale theorists contend that task irrelevant responses are more likely to occur in complex situations, primarily because of the increased threat of failure. Task relevant responses however, are responses that lead to task completion; they are more likely to be aroused in low anxiety individuals, and they combine with task drives leading to successful task completion.

Sarason et al (1960) made the observation that familial reactions, especially from parents, help shape the child's conception of himself as a performing individual so that when he passes into school with its test and test-like experiences there is a psychological similarity to the evaluative experiences he has had at home. In test and test-like situations at school, therefore, anxiety responses similar to those elicited in the test-like situation home are produced. (Sarason et al. pp. 12-13)

In test and evaluative situations the performance of high anxiety children is impaired because of their tendency to make a larger number of task-irrelevant responses and a lesser number of task relevant responses than low anxiety children.

The Yerkes - Dodson Law states that:

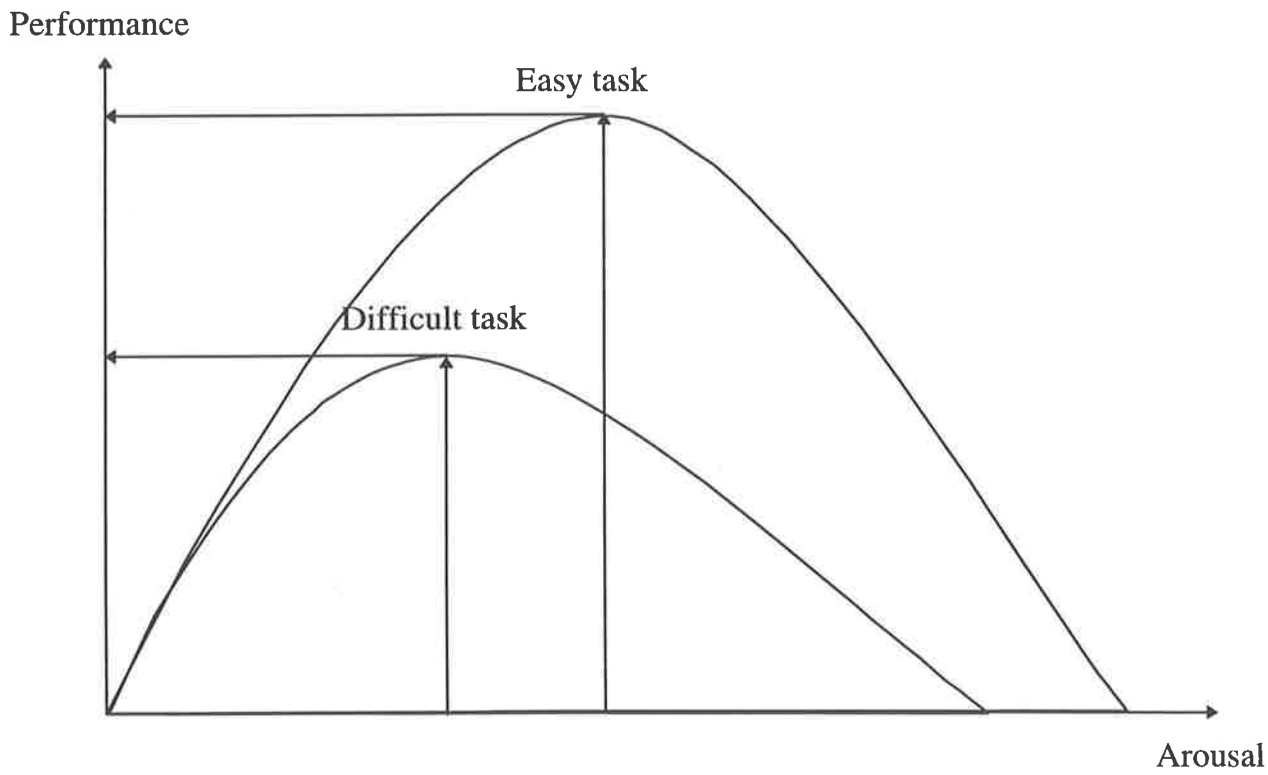
> *There is a tendency for high levels of motivational arousal (such as high anxiety) to facilitate very skilled performances and to disrupt not very skilled performances.* (Yerkes and Dodson, 1908).

The law applies to how well students do in tests; - very anxious students perform well on easy test questions and very poorly on difficult ones. That is, anxiety facilitates learning up to a point - the location of this point being determined by the difficulty of the task.

The Yerkes ~ Dodson law also states that the optimum anxiety level is inversely related to the complexity of the task. Many experimental investigations with human beings indicate that anxiety interferes with performance on complex learning. For example, a student tackling an easy task at which he performs at maximum level will experience some level of anxiety/arousal. However, if the task is a difficult one, a lower level of anxiety/arousal is necessary to bring about a maximum performance. This is illustrated in **Figure 1**.

Figure 1.

Levels of Performance and Anxiety associated with an easy task and a difficult task.



(Goetz, Alexander and Ash,1992, p.547)

In the classroom, for example, children who are reasonably proficient at multiplication but have difficulty with long division may need lots of incentives and coaxing to perform up to their best on multiplication exercises but then need a calm, relaxed atmosphere while they work on their division problems.

Students can modify their own arousal level to optimize performance, and loud noise has been known to increase arousal. However, this might push arousal beyond the optimal level for an already aroused student on a difficult task. The Yerkes ~ Dodson law suggests that when highly aroused, or when working on a really difficult or challenging assignment, students would do well to choose soft and soothing music.

Ames (1978) found that Achievement attribution differed with self-concept. Those with high self-concepts anticipated success, have enhanced self-confidence and show more approach ~ type behaviours. Those with low self-concepts have depressed beliefs about their abilities, are self-critical and have self-worth feelings that interfere with social relationships. Ames postulated that providing success experiences are not enough: '*children with low self concepts must also be taught to be less critical of their own real achievements', (page 354).*

Ames and Archer (1988) in their research about achievement goals in the classroom found sufficient evidence to suggest that Ames' ***mastery structure*** theory provided a context that was likely to foster long-term use of learning strategies and a belief that success is related to one's efforts.

She contrasted performance goal orientation with mastery goal orientation. With the former, the students are judged able when they show evidence of ability by being successful, by out-performing others, or by achievement with little effort. This reflects a valuing of ability and generally high outcomes. With mastery goals, importance is attached to the development of new skills, and, the process of learning for learning's sake is valued. The attainment of mastery is seen to be dependent on effort.

The use of the mastery learning paradigm increases the likelihood of success in the classroom with subsequent reduction in the level of the student's anxiety.

Mastery and performance goals represent different conceptions of success and different reasons for approaching and engaging in achievement activities and involve different ways of thinking about oneself, one's task and task outcomes, (Butler, 1987; Corno and Rohrkemper, 1985; Nicholls and Miller, 1984).

Central to a mastery goal is a belief that effort and outcome covary, and it is this attribution belief pattern that maintains achievement-directed behaviour in the longer term (Weiner, 1979). With a mastery goal individuals are oriented towards developing new skills, trying to understand the work, improving their level of competence or achieving a sense of mastery based on self-referenced standards. Research evidence suggests that a mastery goal is associated with a wide range of motivation-related variables that are conducive to positive achievement activities and are necessary indicators of self-regulated learning, (Ames and Archer, 1988; Nicholls et al, 1985).

Malone and Lepper (1987) described challenge, interest and perceived control as factors that should be embedded in the structure and design of learning tasks. They argued for tasks that offer personal challenge, give students a personal control over either the process or the product and tap students' interests over time. Students' beliefs that they can accomplish a task with reasonable effort, and their willingness to apply the effort, can be enhanced when tasks are defined in terms of specific and short-term goals.

As a result of the mastery paradigm there is a focus on effort and learning. There is a high level of intrinsic interest in the activity being pursued; there is an attribution to effort and to effort-based strategies. There is the use of effective learning and other self-regulatory strategies. There is also active engagement in activities and a positive attitude towards difficult or challenging tasks. Feelings of belonging are apparent and the failure-tolerance level is raised with a consequent lowering of anxiety.

Kahneman (1973) considered the detrimental effects of too low or too high arousal with respect to the role of attention and effort in information processing. On the one hand, when arousal is too low, the student may fail to adopt an appropriate task set or to evaluate performance adequately, diminishing the quality of the effort. On the other hand, when arousal is too high, it interferes with the allocation of cognitive capacity.

Kahneman (1973) likened a person to a limited capacity information processor. If arousal is high and the task is difficult, motivational and task concerns will compete for processing capacity. Hence if a student is thinking about possible rewards or penalties, the student may not pay enough attention to what has to be done to succeed on a difficult task.

Easterbrook (1959) hypothesised that high arousal may restrict the range of cues to which a person can attend, causing the person to miss important information in a complex task. High arousal appears to decrease ability to identify and maintain attention on relevant information, consistent with the observation that the over anxious student is easily distracted.

Dunn (1964) factor analysed the Test Anxiety Scale for Children (TASC) responses of a sample of middle class, upper grades, elementary school children and found that the scale was not unidimensional. He found that there were four factors - test anxiety, generalized school anxiety, recitation anxiety and physiological arousal in anticipated recitation situations. These four factors accounted for 48%, 29%, 14% and 9% of the common variance respectively.

Dunn(1968) independently had replicated the findings of Hammond and Cox(1967) when they established that sections of the Test Anxiety Scale for Children (TASC) scale were more powerful indicators of predicted educational attainment in the classroom than the entire scale itself.

Spence and Taylor (1951) found that high levels of anxiety, as measured by the Manifest Anxiety Scale, interfere with more difficult tasks such as problem solving or complicated concept learning.

Sarason et al (1960) believed that most persons perceive the testing situation to have an evaluative or assessment purpose, and feel that it is important to do well because... "*in our culture the lives of people are frequently affected by their test performance*." (p.8).

As a result of his theory, Sarason hypothesized:

1. *In general, high-test anxiety will interfere with performance on school tests or in situations that are test-like.*

2. *The greater the test-like characteristics of a task, the more the child's anxiety will be manifested and the more it will interfere with the child's performance.*

Sinclair (1969) found that "*in important examinations the **high anxiety** student will be at a considerable disadvantage. When competing with other students for scholarships, university entrance, school prizes, employment opportunities, or simply a place in class, anxiety will act to interfere with and reduce the level of his performance*," (p.305).

The findings in Lund's (1953) study strongly suggest that placing items in an increasing order of difficulty reduces anxiety and yields more valid test scores. In other words, yielding scores that reflect the student's knowledge rather than his anxiety level.

Atkinson and Litwin (1960) showed that success-oriented individuals are likely to set personal goals of intermediate difficulty, that is, have a 50-50 chance of success, whereas anxiety ridden persons set goals that are either very high or very low. If anxiety-ridden individuals fail on the hard task, no one can blame them; and they are almost sure to succeed on the easy task.

Atkinson believes that the tendency to achieve success is influenced by the probability of success and the attractiveness of achieving it. A strong need to avoid failure is likely to develop in people who experience repeated failure and in people who set goals beyond what they think they can accomplish.

Another explanation of motivation is provided by Maslow, (1954, 1968, 1971). He advocated a psychology of health that explores and describes how an individual can reach one's full potential.. He coined the term **self-actualization** to describe the **realization** of one's full potential.

Maslow developed a **hierarchy of needs** to describe the major motives that draw people towards, or away from, becoming **self-actualizing**. His lower level needs – *physiological, security, belonging and esteem* – are termed **deficiency needs**. They are deemed to grow stronger when denied and become weaker when fulfilled. When they are unfulfilled, deficiency needs tend to draw people away from self-actualization.

The needs of *knowledge, understanding, aesthetic pursuits and self-actualization* are known as **growth needs** and are said to increase when they are fulfilled and decrease when they are denied. Growth needs draw people towards self-actualization. According to Maslow, people can only be motivated by growth needs if their deficiency needs have been met.

Maslow suggested that it is more useful to think of self-actualization as a state of being that can be attained by any person during a 'peak experience.'

> *We may define it as an episode or a spurt in which the powers of the person come together in a particularly efficient and intensely enjoyable way, and in which he or she is more integrated and less split, more open for*

> *experience, more idiosyncratic, more perfectly expressive or spontaneous, more fully functioning, more creative, more humerous, more ego-transcending, more independent of his lower needs. He or she becomes in these episodes more truly himself or herself, more perfectly actualizing his or her potentialities, closer to the core of his or her being, more fully human* . (Maslow,1968, p.97).

Maslow's analysis of motivation suggests that the primary responsibility of teachers, principals, supervisors, administrators and of society in general, is to assist in ensuring that students' and teachers' deficiency needs are met and that their growth motives are fostered so that our students and their teachers may function at the highest possible levels.

Hence the concept of self-actualization is related to motivation. Self-actualization refers to an individual's need to develop his or her potential. In other words to do what he or she is capable of doing. Such people make the fullest use of their capabilities.

According to Maslow, self - actualization is thought to be the top need in a hierarchy of needs or motives. The needs in the hierarchy are:

◊ *The need for* ***self actualization***

◊ *Aesthetic needs*

◊ *The needs to know and understand*

◊ *The need for prestige, success, and self-respect –* ***Esteem Needs****.*

◊ *The needs for affection, affiliation and identification –* ***Belongingness and Love Needs.***

◊ *The needs for security, stability and order* ***– Safety Needs.***

◊ *The needs to satisfy hunger thirst and sex –* ***Survival Needs****.*

Maslow determined that basic or deficiency needs must be satisfied first and self-actualization needs satisfied last. Since the higher motives can be satisfied only after those lower down have been satisfied, the higher motives often remain unfulfilled. Feelings of frustration can arise when the goals of these higher motives are not reached.

Maslow defined an Esteem need as follows: - "*All people in our society (with a few exceptions) have a need or desire for a stable, firmly based, usually high evaluation of themselves , for self respect, for self esteem and for the esteem of others.*" (Maslow, 1970, p.450).

The similarity of Atkinson's conception of motivation to Maslow's (1954) theory of motivation is apparent. Both emphasise that the fear of failure must be taken into account in arranging learning experiences. The same point has been stressed by William Glasser (1969) in *Schools Without Fear* and in *The Hidden Society* (1972). Glasser argues that for people to succeed at life in general, they must first experience success in one important aspect of their lives. For most children, that one important part should be school. But the traditional approach to education, which emphasises comparative grading, allows only a minority of students to feel successful. Most students feel that they are failures, which depresses their motivation to achieve in other areas of their lives. Indeed most teaching approaches spend more time attending to, and emphasising failure than success.

Lindgren (1956) modified Maslow's original list of basic human needs, termed internal forces, into five categories arranged in a hierarchy from the most basic to the most advanced. His modified list is shown in the **Table 1.**

Table 1

Lindgren's Basic Needs

Basic or Normal Needs
1. Bodily processes.
2. Safety
3. Love
4. Status, acceptance by group
5. General adequacy, creativity, self expression

The first three needs appear in infancy: hence they are basic to the other needs. Unless these needs are met adequately children and adults alike cannot give sufficient attention and energy to meeting other needs. A child cannot do well at classroom tasks if he is distracted by not knowing where his next meal is coming from, or does not know whether his family will still be intact when he gets home.

Needs at the fourth and fifth levels are concerned with the individual's relations with other individuals or with society at large. Needs at the fourth level are concerned with self-respect and self-esteem, as reflected by and included in the respect and esteem of others. Needs at the fifth level involve self-realization, achieving a sense of personal adequacy, creativity and developing and maintaining a life role that is satisfying and worth while.

An anxiety develops when basic needs are blocked, frustrated or threatened. This is particularly true when the needs at the first, second and third levels are blocked. When our biological needs are thwarted or when our physical safety is threatened our behaviour is more likely to be characterized by fear or anger than by anxiety. Fear and anger are primitive emotions. When we feel irritated when someone in authority accuses us of carelessness, we contain our irritation so as not to jeopardize our status. This is the quality of anxiety. It is illusive, bothersome and hard to identify.

On the other hand, Sweller (1988), and Owen and Sweller (1985) examined the *means ~ end* approach to problem solving. This approach required the establishment of a **schema** which is defined as "*a cognitive structure that specifies both the category to which the problem belongs and the most appropriate moves for problems of that category*", (Sweller, 1988).

A means - end strategy directs attention towards differences between the current problem ~ state and the desired goal ~ state and attempts to find problem solving operators that can reduce the difference. This recursive procedure continues until the goal is attained. One important characteristic of the strategy is that at each step, attention is focussed on the differences between the present state and the next sub - goal. Previous steps are no longer necessary and are often ignored. Previous work (Owen and Sweller, 1985) has suggested that because means - ends analysis directs the attention of problem solvers to the goal, rather than to the sequence of past moves, learning is minimal.

Self-Esteem is defined (Lawrence, 1988) as what a person feels about the discrepancy between the way they are (self-image) and the way they would like to be (the ideal self). Thus a person whose actual and ideal self are very distant from each other, and who therefore has a negative perception of self is said to have a low self esteem. The greater the gap between the ideal self and the self image the greater the degree of anxiety. (Linke, 1996).

Brookover, Erikson and Joiner (1967) and Lawrence (1981), in their research did find evidence to support the earlier findings that there is a positive relationship between the level of one's self-esteem and one's academic achievement.

Academic self concept - in other words, the students' views of themselves as learners - has been posited frequently as an important predictor of achievement motivation, and thus school performance (Song and Hattie 1984; Wylie 1979). Children who view themselves as capable of academic success presumably work harder and therefore perform better than their peers. Hansford and Hattie (1982) found the relationship between academic self-concept and achievement to be positive.

The self enhancement theory of Scheirer and Kraut (1979) in which self concept is assumed to determine achievement, suggests a favourable self concept may be an important precondition for coping with difficult learning situations, which in turn will facilitate academic success. Another possibility is that self ~ concept and academic achievement influence each other in a reciprocal manner. This is reflected in the work of Marsh (1984) who proposed a dynamic equation model suggesting that academic achievement and self concept are inter woven in a network of reciprocal relations such that a change in one variable produces changes in the other to re-establish the equilibrium. His view is also supported by Skaalvik and Hagtvet (1990).

Chapman et al (1981) and his colleagues found evidence for a reciprocal relationship between self ~ concept and achievement across a twelve month interval. Using cross ~ lagged panel analysis, these authors found coefficients ranging from 0.41 to 0.52 between self concept and achievement and vice versa for the two age groups measured. (grades 3 and 4, and grades 5 and 6)

Mathematics Anxiety.

Richardson and Suinn (1972) identified mathematics anxiety as:

"Feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations". (Richardson and Suinn,1972,p. 551)

In addition researchers have been interested in the negative effects of mathematics anxiety on students' achievements in mathematics.

Richardson and Woolfolk (1980) discussed how certain features of mathematics, in particular its precision, logic and emphasis on problem solving made it particularly anxiety provoking for some students. Other studies have documented the negative effects of mathematics anxiety on mathematics performance and achievement. (Richardson and Suinn, 1972; Suinn, Edie, Nicoletti and Spinelli, 1972).

Mathematics anxiety can be a real problem in the classroom. The children are afraid of appearing stupid when they go to the board to work out a problem, or they are seized with panic when faced with a timed test. However, they maintain that it is important that children understand numbers and they suggest that games be incorporated into the classroom as games can do much to eliminate fearful attitudes towards mathematics.

Lazarus (1975a) reminds us that fear of mathematics is widespread and speculates about the aetiology of what he terms mathophobia. One factor he suggests is that difficulty at any level spells trouble for all the years to come. Mathematics curricula rely heavily on a ' *memorize what to do*' approach that makes it difficult to make up deficiencies in skills no longer taught at the current level. It also discourages the kinds of divergent thinking and higher ~ order problem solving that are necessary for success at more advanced levels of mathematics. Secondly, Lazarus states that mathematics anxiety has a peculiar social acceptability. People otherwise proud of their educational attainment shamelessly confess to being " *no good at mathematics*." Thirdly, and most importantly, according to Lazarus, there appears to be a pervasive lack of meaningful connection between school mathematics and the rest of a student's life. According to Lazarus:

> *Instead of trying to teach mathematics for its own sake, colleges should teach it for the students' sakes. Not elaborate arithmetic, which is quickly becoming obsolete thanks to pocket calculators. Not the beauty of mathematics, which leaves all but a few students cold. The focus should be on mathematics that can open their eyes and equip the hands, letting students look upon the world in new and fruitful ways.... The stress should be on relationships between reality and mathematics, encouraging the idea of mathematical modelling to the point where it becomes almost automatic and intuitive.*
>
> (Lazarus, 1975a, p. 38)

Larazus (1975a) hypothesised that much of the mathematics anxiety is caused by too great an emphasis being placed on the aesthetic and historical aspects of mathematics. Also, arithmetic calculations need not be emphasised to the extent that they are in the primary school years of mathematics teaching, as the use of calculators is now well nigh universal.

Lazarus' hypothesis may well be upheld by investigation, but for students to obtain an appreciation of the historical, aesthetic, social and practical aspects of mathematics, all students must be initiated into these mathematical insights. When using a calculator they must be able to recognise that the answer gained by using this process could be wrong due to human error of input.

Scopes (1973), in his book *Mathematics in Secondary Schools, a Teaching Approach*, divides the goals of education in a number of subheadings - utilitarian, social, cultural and personal. He then describes how these goals can be, and should be, an integral part of the teaching of mathematics to schoolchildren.

Morris et al (1981) as a result of the research into '*mathematics anxiety - teaching to avoid it*'- recommended the following:

- ◊ *students be given positive support in the classroom*
- ◊ *students be informed that risk taking is acceptable*
- ◊ *Students to have an understanding of the thought processes involved*
- ◊ *The content of the course must contain some problems dealing with processes and applications as well as problems involving only memorization of data.*
- ◊ *Mathematics must be seen to be for everyone*
- ◊ *Perseverance and application thought processes to be shown to be necessary goals.*

Tobias and Weissbrod (1980) found that people's attitudes towards mathematics were influenced by stress in the classroom. Many children who develop a fear of, and an hostility to, the study of mathematics recall the pain and stress they experienced in mathematics classes - remembering going to the blackboard, timed tests, frequent quizzes, teachers' concerns about students' cheating, and excessive competitiveness in the classroom. This anxiety has been assumed to play a role in students' curriculum and vocational choices and thus to present a potential problem area for many students when making educational and vocational decisions.

Munro (1980) cites mathematics anxiety as an intensely unpleasant emotion ~ response that inhibits learning of mathematics and mathematics related activities. This response can be quite irrational in its intensity causing the sufferer to become irritable, distressed, fearful or withdrawn when confronted with mathematical tasks. If at all possible the high anxiety level student will make every effort to avoid mathematics and mathematical learning.

Munro cited five case studies of adults and children suffering from mathematics anxiety. Several characteristics were illustrated:

◊ *Mathematics anxiety is a learned emotional response to a set of circumstances over which the sufferer feels he has little control;*

◊ *Mathematics anxiety is not necessarily associated with low achievement;*

◊ *Mathematics anxiety is an emotional response experienced not only by females.*

Mathematics anxiety does not only affect students who have performed badly in mathematics. Average mathematics learners and high achievers can experience uncomfortable and often debilitating mathematics anxiety responses. Many of these students, although doing well in mathematics, did not enjoy, or value, learning mathematics and experienced fear and panic in the mathematics learning situation, especially when they made errors. Frequently they believed that they were not doing as well as they could, sometimes their classroom peers were performing at a higher level and they perceived themselves as "not good" students. Frequently these students expressed a desire to avoid learning mathematics although they believed that it was not in their long-term interests to do so.

Munro posed the question - *What causes mathematics anxiety?*

He responded that generally, anxious responses are elicited when an individual perceives a threat, but cannot remove himself from the stressful situation. In the classroom situation the student may fear that he will not be valued as much by his parents or teachers, or he will be less acceptable to his peers if he is not successful in mathematics. Secondly, the student may feel threatened by the errors that he makes in the mathematical situation. Thirdly, he may believe that future aspirations and opportunities will be lost if he is not successful in mathematics learning. Fourthly, the student may feel that his self-concept is under threat if he experiences difficulties in learning mathematics.

The Mathematics Anxiety Rating Scale (MARS) was developed by Suinn, and Richardson (1971). The scale was said to be unidimensional in that it measured test anxiety only. However, Rounds and Hendel (1980) in their analysis of the MARS identified two factors - Mathematics Test Anxiety and Numerical Anxiety.

The author, Wither (1987) in his studies of *Some Influences on Achievement in Secondary School Mathematics* found that test anxiety and number manipulation anxiety were factors of the Mathematics Anxiety Scale (MAS) of Rounds and Hendel. The number manipulation anxiety factor had a high negative correlation with the mathematics achievement test, the attitude towards mathematics scale, value of mathematics scale and the enjoyment of mathematics scale.

Consequent to this finding, the author has developed a number of mathematics anxiety rating scales, one for each of the school years six, seven, eight, nine and ten. These scales have been used in conjunction with the mathematics ability tests 2A, 2B, 3A, 3B as developed by the Australian Council of Educational Research (ACER). They were also used with tests 8A, 8B, 9A, 9B, 10A and 10B, developed by the author using, and being fully cognisant of, the syllabuses of years 8, 9 and 10 school mathematics in South Australia.

Resnik, Viehe and Segal (1982) factor analysed the Mathematics Anxiety Rating Scale (MARS) using principal component analysis and varimax rotation. Three factors - Evaluation Anxiety, Arithmetic Computation Anxiety and Social Responsibility Anxiety were identified.

Number anxiety is associated with the fear of arithmetic. One reason why arithmetic, more than other school subjects, can create anxiety is because it is abstract and yet the answers are so definitely right or wrong; one can easily feel out of control. If a person is prone to anxiety and has little grasp of number concepts, the situation is particularly threatening: one is right, or more usually wrong, for mysterious reasons that one cannot explain. (Biggs, 1992)

Dreger and Aiken (1957) in their research on number anxiety in college students ascertained that number anxiety was distinct from general anxiety, that it bore no relationship to intelligence, but both types of anxiety correlated highly with low mathematics grades.

Frary and Ling (1983) in their *Factor Analytic Study of Mathematics Anxiety* found that mathematics anxiety was significantly related to attitude, to low mathematics achievement and to the avoidance of mathematics.

In a study concerning study skill counselling with respect to mathematics anxiety it has been found that cue controlled relaxation was the most effective intervention in the reduction of mathematics anxiety and improving mathematics performance. Recommendations resulting from the study, are that teachers:

- ◊ *Be aware that mathematics anxiety exists*
- ◊ *Be aware of the facilities to determine mathematics anxiety*
- ◊ *Be prepared to emphasize the relevance of mathematics*
- ◊ *Make an effort to integrate mathematics with other disciplines*
- ◊ *Be aware that remedial mathematics tutoring be available*
- ◊ *Evaluate their own methods*
- ◊ *Initiate or continue more research.*

Chapter 3.

Some Theories of Anxiety in general

and

Mathematics Anxiety in particular.

Anxiety has fostered strong research concerns within the last twenty five years. The construct is broadly defined to be a state of emotion underpinned by qualities of fear and dread. This emotion is unpleasant, is directed towards the future and is out of all proportion to the real threat. Its special characteristics are " *the feelings of uncertainty and unpleasantness in the face of danger.*" (May, 1977, p.205). Anxiety is an all-encompassing construct, and under its rubric there has appeared a host of sub constructs that relate to discrete situations. In academic situations, two of these seem prominent: test anxiety and mathematics anxiety.

Before we examine the latter anxiety, it will help to look at the former.

From its beginning, the research on test anxiety has proceeded on well-defined theoretical paths. The effect of test anxiety on performance has remained a focal concern.

The origins of anxiety

Forces inside the individual and forces outside the individual produce behaviour. Sometimes the individual is figuratively or literally pushed into a given act, but most likely whatever he does is the result of the interplay and interaction of many forces, both internal and external. By internal forces we mean needs, wants, anxieties, interests, feelings of guilt and so forth. By outside forces we mean the requirements of society, rewards, dangers, threats and the expectations of other people. It is often difficult to tell where an internal pressure ends and an external pressure begins. The differences between internal and external forces may not be very sharp or precise, or these forces may interplay.

The observations and experiences of Sullivan (1953) led him to the conviction that the initial experiences with anxiety occur in infancy, when infants sense the displeasure or disturbed emotional tone in their parents, particularly their mothers.

Sullivan observed that infants display such symptoms as restlessness, irritability and feeding problems when their mothers are displeased or disappointed, even when their mothers are troubled by events that have nothing to do with the child. So close is the emotional linkage between mothers and infants, according to Sullivan, that negative feelings are likely to have the effect of disturbing the infant's sense of security, need to be loved and feelings of security in his mother's love. These feelings of insecurity and isolation Sullivan terms ***anxiety***. As we grow from infancy to childhood, anxiety continues to play an important part in our lives. It appears whenever others criticise, snub or disapprove of us - then we are rejected. The more important the rejecting individual is to us and the more power that person has, the greater the anxiety. Anxiety is such a painful and disturbing emotion that we will go to great lengths and will lay careful plans to avoid behaviour that may arouse anxiety.

According to Anderson (1950) " *the basis of all behaviour is the avoidance of anxiety. Everything one does, every choice one makes, every reaction one gives, every item detail of one's behaviour is calculated to forestall anxiety or to deal with it when it arises.*"

In the general arousal or activation theory of Duffy (1962, 1972) two factors are involved in an emotional state; a degree of activation, either high or low, of the organism; and a direction. The activation or arousal aspect takes place on the physiological level and is non specific, although it varies among different individuals. Various measures of arousal such as blood pressure, heart rate, levels of perspiration have been found to be constantly interrelated in an individual, though not necessarily among all individuals. The direction aspect exists on the psychological - behaviour level. When a person says that he is afraid or that he is hungry, his level of physiological arousal may be the same, but the direction of his behaviour is likely to be very different. A person who experiences a feeling of fear is likely to move away from the stressful stimulus. The angry person is likely to move toward the stressful stimulus.

On the basis of this arousal theory, several predictions can be advanced. Emotions like anxiety and anger are so intertwined by means of learning experiences that individuals commonly report mixed feelings resulting from stimulation, or are unable to distinguish reliably between the two feelings. The experience of joy or mirth is distinctly different from that of anxiety and anger. According to the arousal theory, the physiological accompaniments should be much the same.

Several studies suggest that this is, in fact, the case. Levi (1963) showed his subjects the tragic war film, *Paths of Glory*, and the comical film, *Charlie's Aunt*. Behaviourally, and in self-reports, the subjects reacted as expected. In another experiment by Schachter and Wheeler (1962) one group of subjects received an injection of adrenalin; another, an inert placebo; and the third group, chlorpromazine, a drug that inhibits emotional arousal. All groups were then shown a brief funny film. Manifest reactions of amusement were noted and accumulated into an 'amusement index'. The adrenalin - injected group had the highest amusement index, with the placebo group next and the chlorpromazine group showing the least amusement.

A logical inference from this study is that adrenalin causes a state of arousal the direction of which is then determined by an external stimulus that is perceived independently by the subject. The experiment is in accord with Duffy's idea that the direction of emotion is determined by the individual's perception of the situation within which he experiences general arousal.

Schachter and Wheeler (1962) stated this hypothesis:

> *Given such a state of arousal, it is suggested that one*

labels, interprets and identifies this state in terms of the characteristics of the precipitating situation and one's apperceptive mass. This suggests then, that an emotional state may be considered a function of a state of physiological arousal and cognition appropriate to this state of arousal. The cognition, in a sense, exerts a steering function. Cognitions arising from an immediate situation interpreted by past experiences provide the framework within which one understands and labels one's feelings. It is the cognition which determines whether the state of physiological arousal will be labelled 'anger', 'joy', or whatever. (Schachter and Wheeler,1962, p.139).

Schachter and Singer (1962) devised an experiment to test this hypothesis directly and the findings appeared to support the general arousal hypothesis advanced by Duffy and others. (Levitt, 1980, pp 82 - 83).

A great deal of experimental work dealing with the effect of anxiety on learning has been carried on at the University of Iowa under the direction or influence of the late Kenneth W. Spence. Spence conceived of anxiety as an acquired ***drive*** that has the capacity to energize generally the organism. (Spence, 1960; Spence and Spence, 1966). For this reason, Spence's formulation has been called ***Drive Theory***.

Anxiety, conceptualized as drive, ought to increase the speed of learning and thereby facilitate performance.

Drive theory is straightforward when applied to learning situations in which only one response is possible and occurs invariably, as in the case with the conditioning of a reflex. The individual either responds to the conditioned stimulus with a reflex act or he does not respond; there is no choice of responses. In this kind of situation, a high anxiety level should, by energizing the individual to behave, facilitate learning.

However, the single - response learning situation does not occur frequently in human life. In most learning circumstances, a variety of possible responses is available to the individual. Each of these response tendencies or '***habits***' has a certain strength or probability of occurrence, depending on the individual's past experience. These responses theoretically could be arranged in a ***hierarchy*** of habit strength.

Spence's theory holds that anxiety will energize or strengthen each of the habits in the hierarchy in proportion to the initial strength of the habit. Using Spence's theory, one way in which to define a ' simple task' is to say that for most people the correct response initially ranks high in the habit hierarchy. Most human learning, however, is complex. And a complex situation is one in which there are a number of competing response tendencies, all of which are equally weak in habit strength. An effect of anxiety as an energizer is to increase the habit strength of the many incorrect response tendencies to the disadvantage of the lone correct response. In this situation desired learning will thus proceed more slowly.

A simple mathematical formula describes the effect of anxiety on any one-response tendency:

D(rive) x **H**(abit strength) = **R**(esponse)

In the Iowa theory, anxiety is used in the sense of a constant characteristic of the individual. The exclusive use of the Manifest Anxiety Scale (MAS) as a measure of energizing drive indicates that the evoking of anxiety in the anxiety - prone individual is regarded primarily as a function of a condition of the individual, and secondly as a function of external stimuli.

An opposing view had been advanced by psychologists at Yale, led by Mandler and Sarason (Mandler and Sarason, 1952; Sarason et al, 1975; Sarason et al, 1960). The Yale position is expressed as follows:

1. *Anxiety is a strong learned drive that is situationally evoked.*
2. *The individual has learned or developed characteristic responses to anxiety that are brought to the current situation. These reactions may be* ***task - irrelevant*** *- that is, tending to disrupt performance, or they may be* ***task - relevant*** *- thus being facilitative of performance.*
3. *The effect of anxiety is also a function of such aspects of the situation or the attitude of the experimenter or teacher, and the meaning of the task as perceived by the individual. These factors are of greater significance than the complexity or difficulty of the task per se.*
4. *Because of the 'nebulous character of the concept of general anxiety' (Sarason, 1975) and because of the intrinsic value of studying more*

specific anxiety traits, attention should be focused on the latter rather than the former.

The Yale theorists selected for study a limited area of the concept, called ***test anxiety***, 'test' referring primarily to the ordinary classroom evaluation. Mandler and Sarason maintained that reactions to anxiety are task relevant or task irrelevant depending to a great extent, on the specific nature of the task itself.

One way in which to test the hypothesis concerning the nature of the task is deliberately to structure a learning situation in which theoretically, the anxiety - prone individual should perform more effectively than his less anxious peer even though the task can hardly be considered a simple one.

Ruebush (1960) presented to a group of sixth grade students a task which required them to locate a figure embedded in a matrix of lines. Each individual was free to work as slowly or rapidly as he pleased. Individuals with a high disposition to anxiety consistently require more time to complete complex tasks of various kinds. Thus it would be expected that anxiety - prone children in the Ruebush's sample would be slower and more cautious in their approach to the task. This is exactly what Ruebush found to be the case.

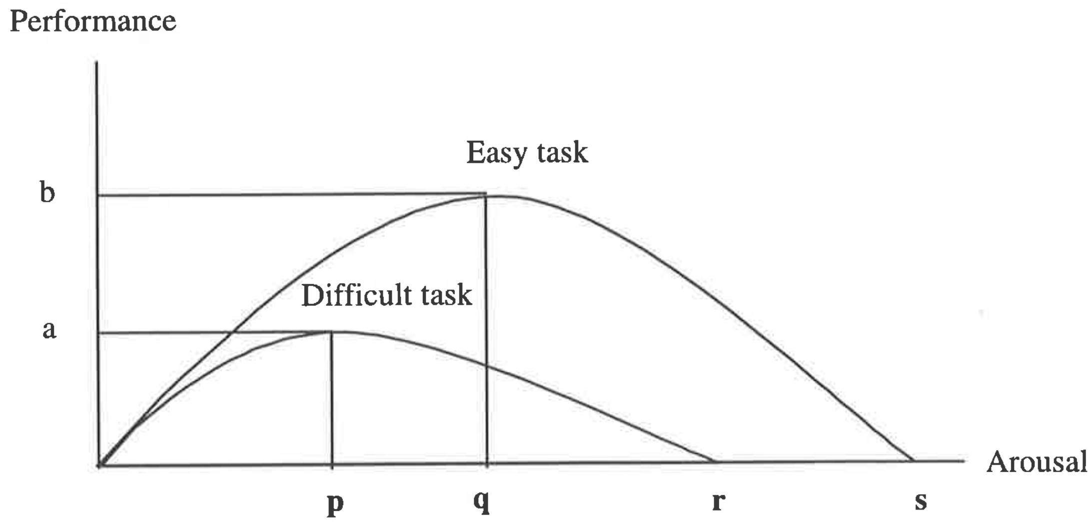
The Yerkes ~ Dodson Law (1908) is one of the earliest experimentally based statements of the relationship between drive and learning. The Yerkes ~ Dodson Law holds that the relationship between fear, conceptualized as a drive, and learning, is curvilinear. A low level of drive facilitates learning only slightly or not at all - presumably because the motivation it provides is inadequate to affect performance. A high level interferes with the learning process, so that performance is similar to, or worse than, that obtained with low drive. The level of drive that stimulates optimum performance lies somewhere in the middle range of drive intensity.

The law also states that the relationship between drive and performance is a function of task complexity. The optimum drive level is higher when the task is simple than when it is complex; a drive level that facilitates performance on a simple task may disrupt it when the task is more difficult.

When performance is measured in terms of errors, or the time to complete the task or the number of trials necessary to reach a criterion level, the curve describing the relationship is **U** - shaped. It is an inverted - **U** when the measure is the number of correct responses in a given time or a number of trials required to gain a maximum score. The relationship is illustrated in **Figure 2**

Figure 2

Performance levels and arousal levels with respect to an easy task and a difficult task.



With respect to the easy task, when arousal is raised to level *q* maximum performance is attained at level *b*. When the level of arousal increases beyond that level the performance declines, until at point *s*, the performance is zero. A difficult task requires a lesser level of arousal in order that a maximum level of performance is reached. At level *p* of arousal, the greatest level of performance is attained at level *a*. Should the level of arousal increase beyond level *p*, the output falls below the previous maximum level, reaching zero level at point *r* on the arousal scale.

Some Measures of Anxiety

Gaudry and Spielberger (1971) are of the Yale school of thought. They identified four measures of anxiety and the theoretical foundation on the basis of which each of these measures was constructed. The measures are:

◊ **The Manifest Anxiety Scale.(MAS)**

◊ **Test Anxiety Questionnaire (TAQ)**

◊ **Achievement Anxiety Test (AAT)**

◊ **The State ~ Trait Anxiety Inventory (STAI)**

The Manifest Anxiety Scale.(MAS)

Taylor (1953) and Spence (1958) developed the Manifest Anxiety Scale (MAS). The MAS is a measure of a general trait or predisposition to experience anxiety. The words "*often*", "*frequently*", "*usually*", and "*hardly ever*" occur throughout the scale questions. Students are not required to report on their emotional state as it exists at any particular time.

This scale consists of fifty statements like: '*I blush easily*'; '*I worry more* *than other people'; 'I frequently find myself worrying about something'; 'I always have enough energy when faced with difficulty.'* The subject is asked to indicate whether each statement is true or false about him/her, and the subject's score is based on the total number of items marked in such a way as to indicate the presence of anxiety as a personality trait.

[The mathematics anxiety scale used in the study which is the focus of this thesis, was of a similar construction to the Manifest Anxiety Scale. However, there were two differences - first, the content only dealt with situations relating to the use and/or understanding of mathematics at the level consistent with the age of the subjects. Secondly, each statement required an answer in the range of ***'It doesn't worry me at all'*** to ***'It worries me an awful lot'*** on a five point scale. In order to minimize the possibility of test anxiety among the subjects, the test was untimed, but they were asked to work through the scale quite quickly writing down their first considered answer.]

Taylor and Chapman (1955) in their research into "*Paired ~ Associate Learning as Related to Anxiety*" found that the high anxious students performed better on simple tasks than the low anxious students, but that they performed worse than low-anxious students on complex tasks.

The Test Anxiety Questionnaire (TAQ)

The Test Anxiety Questionnaire (TAQ) was constructed by Mandler and Sarason (1952), to measure the anxiety reaction of adults taking course examinations or intelligence tests. The Test Anxiety Scale (TAS), Mandler and Cowan (1958), is a high school version and the Test Anxiety Scale for Children (TASC) was developed by Sarason et al (1960) as a measure of the anxiety that is aroused in children (elementary school age) by test or test ~ like situations. The focus on test anxiety arises to a great extent, from the fact that almost all members of our society frequently encounter test situations. Most people consider a test situation as having an assessment or evaluative purpose and feel that it is important to do well because "*in our culture the lives of people are very frequently affected by their test performance*" (Sarason et al, 1960, p.8). According to Sarason's concept of anxiety , the development of anxiety commences from the earliest years of our lives. Thus, the child's behaviour is constantly being monitored and evaluated by his or her parents with the possible outcomes that adverse evaluations may evoke feelings of hostility in the child, and these hostile feelings cannot be expressed because of the child's dependence on his or her parents for approval, direction and support. Consequently feelings of anxiety are aroused in the child. In situations where the child feels he or she is being evaluated and therefore in a danger situation, performance may be impaired and the resulting anxiety will interfere with an adequate perception of external events and task performance. Such test anxiety can be aroused in school situations because of the similarities between the authority of the parents and the teacher. The test ~ anxious child often pays more attention to his or her own anxiety responses in a test situation than to the task. As a result, performance may be impaired if certain cues are recognized which inform the child that he is being evaluated and therefore in a danger situation. Both parent and teacher are seen as figures with authority and with power to perform evaluative functions, to dispense rewards and punishments. Mandler and Sarason implied that measurable anxiety responses, when present, are debilitating to performance, an implication which is reflected in their Test Anxiety Scale (TAS). All of the items in the test anxiety scale are bipolar, ie. anxiety responses are either debilitating or not. (For example, **while taking a course examination to what extent do you *worry*? *Worry a lot … to …***

worry not at all). (Item No. 35). From a low score on the test (TAS), Mandler and Sarason infer that when anxiety-provoking cues are not present the student's general drive will be more focused on the task in hand and improved performance will result.

Gaudry and Spielberger draw a number of hypotheses from Sarason's theory:

(1) In general, high test anxiety will interfere with performance in school tests or in situations which are test ~ like;

(2) the greater the test ~ like characteristics of the task, the more the student's anxiety will be manifested and the more it will interfere with performance;

(3) conversely, any reduction in the test ~ like characteristics of the test should reduce the impairing effects of anxiety. This might be brought about by eliminating time limits, or by giving cues to correct answers;

(4) high test anxious students will be more dependent and non aggressive than low test anxious students. (Gaudry and Spielberger, 1971, p.13).

However, they do not reach any conclusions about these hypotheses.

Achievement Anxiety Test (AAT)

Study of the anxiety literature provokes the question of how anxiety, when aroused in an examination, will affect performance; that is, whether it will facilitate it or debilitate it, or perhaps have no effect on it at all.

Mandler and Sarason (1952) developed the Test Anxiety Scale endeavouring to ascertain the level of test anxiety in anxious students. Taylor (1953) developed a general anxiety scale called the Manifest Anxiety Scale. This scale is concerned with a wide variety of situations other than test anxiety.

Alpert and Haber (1960) constructed the Achievement Anxiety Test (AAT) in order to identify individual students whose academic performance is *facilitated* by the stress of the test situation, as well as those students whose performance is *impaired* by the test situation (ie. a specific anxiety scale). One scale of the AAT measures the facilitating effects of anxiety on achievement, and a separate scale measures the debilitating effects of anxiety on achievement. The facilitating scale of nine items was based on a prototype of the item "*Anxiety helps me do better during examinations and tests*", and the debilitating scale of ten items was based on the prototype of the item, "*Anxiety interferes with my performance during examinations and tests.*" Both scales were revised numerous times based upon item analyses, correlations with various criteria and theoretical reformulations. The test-retest reliability over a ten-week interval was 0.83 for the facilitating scale and 0.87 for the debilitating scale. Over an 8-month period the test-retest reliability was 0.75 for the facilitating scale and 0.76 for the debilitating scale. The two scales were administered on one questionnaire, the items being randomly mixed. The students answered each item on a five point Likert type scale, indicating the degree to which the item applied to them.

Empirical techniques were also used to refine the two scales. After a large number of items had been constructed for each scale, the scales were used to predict several performance criteria such as grade-point averages and final examination grades. The data was item analysed to give the correlation of each item with the criteria. The items which were highly correlated with the criteria but which were not correlated with each other were retained. In this manner it was hoped the inter correlations of the scales would be minimised without their validity coefficients being affected. The final correlation between the facilitating and debilitating scales were - 0.37, - 0.34, - 0.43 and - 0.48 drawn from four different samples. The correlations were significant beyond the 1% level. Hence, in spite of efforts to separate the two scales empirically a low but significant correlation remains. As a result of their findings, the following conclusions can be supported:

◊ *Specific anxiety scales (having items specific to the academic test situation) and general anxiety scales are measuring to a significant extent, something different from each other.*

◊ *The specific anxiety scales are better predictions of academic performance than are the general anxiety scales.*

◊ *The general anxiety scales are not significantly related to verbal aptitude, while the specific anxiety scales are all related to aptitude.*

◊ *The specific anxiety scales, although more highly correlated with aptitude than the general anxiety scales are nevertheless more often than the general anxiety scales able to account for variance in academic performance other than that accounted for by a measure of aptitude.*(Alpert and Haber, 1960, p.215)

The results of Alpert and Haber (1960) were utilized in the current study in so far as the anxiety scale used was subject specific (mathematics). As a result of earlier studies, (Suinn, and Richardson, 1972); Fennema and Sherman (1976b); and Wither (1987), the specific anxiety scales, in the respect that they related to mathematics, were found to be reliable predictors of academic performance.

The State ~ Trait Anxiety Inventory (STAI)

This fourth questionnaire to measure individual differences in anxiety proneness was developed by Spielberger and Gorsuch (1966) and Spielberger, Gorsuch and Lushene (1970) State anxiety (A-State) as defined by Spielberger et al (1970,p.2) is conceptualised as - ***a transitory emotional state or condition of the human organism that is characterized by subjective, consciously perceived feelings of tension and apprehension and heightened autonomic nervous system activity*** . 'A-State' anxiety may vary in intensity and fluctuate over time.

Trait anxiety (A-Trait) refers to ***relatively stable individual differences in anxiety proneness***, that is, to differences between people in the tendency to respond to situations perceived as threatening with increases in 'A-State' intensity.

In general it would be expected that those who are high in A-Trait will exhibit A-State increases more frequently than low A-State individuals because they tend to perceive a wider range of situations as dangerous or threatening. High A-Trait persons are also more likely to respond to stressful situations with increased A-State intensity, especially in situations that involve interpersonal relationships which impose some threat to self esteem.

The concepts of state and trait anxiety have a great deal of significance for the academic learning situation. It seems reasonable to assume that some children may be anxious in many different situations and circumstances while others will rarely experience anxiety at all. For instance, a student, low in A-Trait anxiety may be quite calm in most testing situations, but may react with intense anxiety when faced with an examination in mathematics because of a past history of failure in this area.

The STAI consists of separate reporting scales for measuring the two anxiety scales. The A-State scale consists of 20 items that require the subject to indicate how he feels at a particular moment in time. The STAI A-Trait scale consists of 20 items also that ask people to describe how they feel generally. The responses are on a four - point scale: ***almost never, sometimes, often, almost always*** .

Penney (1965) reasoned that the anxious child would be less prone to explore unknown and unfamiliar situations. Penney and McCann (1964) constructed the Children's Reactive Curiosity Scale (CRCS) which purportedly measured the reactive curiosity of children in grades four, five and six. Penney's definition of reactive curiosity emphasizes the seeking of stimulus variation in a variety of situations. Penney's subjects were 178 children in grades four, five and six of a single elementary school in Austin, Texas. There were 63 children in grade four, 59 children in grade five and 56 children in grade six. A total of six classrooms participated in the study. The CRCS was employed. It is a 90 item paper and pencil scale and each item is answered *'true'* or *'false'* depending on whether the statement is true or false.

The Children's Manifest Anxiety Scale (CMAS) was also used. It consisted of 53 items to be answered true or false.

The Pearson product moment correlations were computed for the different grade levels and sexes. The correlations between the Manifest Anxiety scores and the Reactive Curiosity scores are shown in **table 2**.

Table 2

The Correlations between the Manifest Anxiety scores and the Reactive Curiosity scores as Measured by Penney*

	Girls		Boys	
Grade	r	p	r	p
4	- 0.38	< 0.025	- 0.49	< 0.005
5	- 0.26	-	- 0.32	< 0.05
6	- 0.42	< 0.01	- 0.17	-

* from Child Development, 1965, 36, 700.

As can be seen from the table all of the correlations are significant except the correlations for grade 5 girls and grade 6 boys.

Evidence from a number of independent empirical investigations (Castaneda et al, 1956; Cowen, et al 1963; Holloway, 1958, 1961; Kitano, 1960; Muuss, 1960) indicate that the correlation between anxiety as measured by the CMAS and the tendency to falsify as measured by an 11 - item Lie (L) scale does not differ significantly from zero, thus supporting the assumption that Anxiety Scale responses of young children, in this case grade three children, relate more closely to the content and meaning of the test items than is the case with adults.

The data for Cowen et al's (1963) investigation was based on two samples of 178 and 216 nine year old (third grade) students from three public elementary schools in Rochester, New York. All three schools were considered to draw children primarily from the upper - lower socioeconomic bracket and the average IQ in each school was slightly above 100. The first sample consisted of 87 boys and 91 girls, the comparable figures in the second sample were 122 and 94 respectively. All analyses of the investigation were based on the total groups and the two gender subgroups for both samples.

Pearson product-moment correlation coefficients, relating anxiety scale score to scores on each of the other 22 variables, were computed for boys, girls and total groups in both samples.

Cowen et al (1963) report that the results were quite logical and internally consistent, each significant relation seemingly consistent with the consensus of current clinical thinking, empirical thinking and empirical findings with respect to the correlates of anxiety and how to perform in a variety of areas. In particular Cowen found that the anxiety measures related negatively with respect to arithmetic reasoning and computation. The correlation of the CMAS and SRA Arithmetic reasoning, concepts and computation are shown in **table 3**.

Table 3

Correlations Between The Children's Manifest Anxiety Scale and Arithmetic Reasoning, Concepts and Computation.**

	Total group		Boys		Girls	
Variable	1	2	1	2	1	2
Arith. Reason	- .10	- ..29**	- .06	- .25**	- .13	- .31**
Arith. Concepts	-.19*	- .27**	- .20	- .27**	- .14	- .27**
Arith. Computation	- .06	- .30**	- .11	- .25**	- .02	- .39**

* $p \leq 0.05$ ** $p \leq 0.01$

**developed from Cowen et al (1965), Child Development, 1965, 36, 2, 690.

Cowen concludes that the significant correlations range between - 0.19 and - 0.39.

Not only has there been considerable prior empirical evidence indicating the negative relation between anxiety and measures of achievement, the bulk of these data pertain to somewhat older children, but also there is additional evidence (Ruebush, 1963) suggesting that the relation becomes stronger with age. Cowen goes on to say that his findings indicate that these same relations are, in fact, present among 9 year - old children and they are to be found quite early in the child's career. "We concluded then, that high anxiety as measured by the CMAS scale, is inversely related to ... educational achievement among 9 year - old children." (1963, p.693)

Lonigan, Carey and Finch (1994) in their research on children diagnosed with either an anxiety disorder or a depressive disorder, reported that anxious children reported more worry about their future, their well being and the reactions of others. They used the Revised Children's Manifest Anxiety Scale (RCMAS) - a 37-item questionnaire designed to assess the presence or absence of anxiety - related symptoms. Of the 37 items 28 measure anxiety and the remaining 9 tap social desirability in responding. The children responded to each item in a yes - no format. The correlations between low interest or low motivation scales and the RCMAS was 0.39 ($p < 0.001$).

Taken a stage further, it also suggests that the anxious child would prefer school routine, not one in which constant change is taking place or one in which children are largely thrown to their own devices.

Test Anxiety

As another method of reducing the interfering effects of anxiety during test situations, the test construction experts advise teachers to arrange their test questions so that the items are presented in increasing order of difficulty. Lund (1953) checked this advice by giving two parallel forms of an untimed test. The first form was arranged in such a manner that the items were presented in an increasing order of difficulty; in the second untimed test, some difficult questions appeared in the early part of the paper. Lund found that the students performed worse on the second untimed test. Thus we may speculate that the effects of the anxiety aroused by encountering a difficult item early in the test persist over time and cause students to miss easy items that would have been answered correctly if anxiety had not interfered.

The prime concern of the study by Lunneborg (1964) was the effect of test ~ taking attitudes upon anxiety measures in children. Her subjects were 213 students in grades four, five and six, ~ 117 boys and 96 girls. They ranged in age from 8 to 10 years.

The materials consisted of a six-page questionnaire of 162 items plus a core sheet on which students indicated name, age, sex, grade and school. The questionnaire contained 42 statements from the CMAS, 11 from the CMASL scale, 34 from the GASC, 11 from the GASCL scale, 30 from the TASC, the 28 item SD scale and 6 reading comprehension items with 'yes' and 'no' to the right of them. All items were randomly ordered, each page containing 27 items.

Metropolitan Achievement Test stanine scores for reading and arithmetic problem solving from a battery administered three weeks prior to the questionnaire were also secured. The results with respect to anxiety and achievement correlated negatively. Of the three anxiety measures the TASC produced the greatest negative correlation. This negative relation tended to be stronger for girls than for boys and to increase in strength the higher the grade level, in accord with results of Sarason et al (1960). These results are shown in **Table 4.**

Table 4:

Correlation Coefficients for Total Group of 213 Subjects *

Test	Reading Achievement	Arithmetic Achievement
CMAS	- 0.18**	- 0.24**
TASC	- 0.32**	- 0.31**
GASC	- 0.22**	- 0.24**

*adapted from Lunneborg (1964), Child Development, 1964, 35, 1, 175.

** $p < 0.01$

Table 5 shows the results of the correlations between the three anxiety scales and arithmetic achievement for the two groups of students as they progressed from grade 4 to grade 6.

Table 5

Correlation Coefficients Between Arithmetic Achievement and the Three Anxiety Scales for Students in Grades Four to Six *

	Arithmetic Achievement					
	Boys			Girls		
Scale	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6
CMAS	- 0.05	- 0.17	- 0.21	- 0.25	- 0.50	- 0.50
TASC	- 0.08	- 0.34	- 0.31	- 0.19	- 0.56	- 0.60
GASC	- 0.12	- 0.16	- 0.41	- 0.29	- 0.48	- 0.52

* Adapted from Lunneborg (1964) Child Development, 35, 1, 276 - 177

With respect to the male students at grade four level, the correlations between arithmetic achievement and the three anxiety scales were very low. However, the correlations did increase as the students progressed through grade five to grade six. The correlations were also in the expected negative direction. On the other hand, the female students at grade four level did register correlations between achievement and the anxiety scales at a significant level and in the expected direction. It can also be seen that their correlations increased as they progressed through the three grades.

Mathematics Anxiety

The theory established by Yerkes and Dodson (1908) was in relation to an increase in anxiety which, in the early levels did in fact, facilitate performance or achievement. As the level of anxiety increased the performance of the student also increased until, at a certain level of anxiety, performance began to decline, and with every increase in the level of anxiety thereafter, the performance level maintained its steady decline. This is illustrated in an anecdotal story by reference to two performers; one, Julie Andrews, the other a school boy named Albert Shanks. When Julie Andrews is practicing or rehearsing she sings very well indeed, but when she performs before an audience at Carnegie Hall in New York, she sings superbly. Albert, when he practices for his solo performance before his classmates, strikes every note and chord correctly and maintains his sense of rhythm. However, in front of a more public audience he strikes wrong chords and does not play at anywhere near his best. Why does this catastrophe happen to Albert?

According to Yerkes and Dodson, Julie Andrews had *overlearned* her performance pieces, and the increased level of anxiety aroused by her having to perform before a very large audience had a positive influence on her performance because she had overlearned the pieces, thus allowing her to focus on the task on hand. Albert, on the other hand, is still learning his performance pieces. The anxiety generated by the thought of having to perform before a live audience interfered with the execution of his music and the retention of the steps necessary to perform to the best of his ability. Over a period of time Albert, like Julie Andrews, could *overlearn* his performance pieces and when playing in front of his class mates he would play even better than he was able during his latest practice sessions.

The Conclusion that can be deduced from that anecdotal story and supported by Yerkes and Dodson is that performance can be enhanced by some anxiety but it deteriorates with too high a level of anxiety.

From the theory of Yerkes and Dodson concerning the level of performance compared with the level of anxiety, three sets of hypotheses can be drawn:

- ◊ *When anxiety is very high performance is very low;*
- ◊ *When anxiety is very low, performance is low,*
- ◊ *When anxiety is moderate, performance is optimum.*

The rationale for these hypotheses is that, according to Yerkes and Dodson, low arousal leads to low motivation to perform, moderate arousal leads to optimum performance, and very high arousal impedes performance. With respect to mathematics, the hypotheses can be formulated as follows:

- ◊ *When mathematics anxiety is very high the level of mathematics achievement is very low,*
- ◊ *When mathematics anxiety is very low, the level of mathematics achievement is low,*
- ◊ *When the level of mathematics anxiety is moderate, the level of mathematics achievement is optimum.*

Mathematics anxiety defined as '*feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations*'(Richardson and Suinn, 1972), is postulated to affect both the extent to which a student pursues any more than the minimally required amount of mathematics learning or experiences in mathematical activities and the extent to which he or she is able to learn and perform mathematics skills and concepts. Thus, mathematics anxiety may be a critical factor in a student's educational and vocational decisions and, in addition, may influence a student's achievement of his or her educational and career goals.

In the field of mathematics, the learning of the rules and language of mathematics may not create any increase in anxiety, but the application of these rules in unfamiliar situations could well cause anxiety levels to increase. Also, the learning of the language of mathematics is of a cumulative nature. Any steps missing in the work of the previous year, term, week or even lesson will create a feeling of the unknown in the mathematics anxious child. According to Penney, the student will not be eager to explore this new language - particularly if the rate of learning required is deemed too fast for the anxious child.

Mathematics anxiety is evidenced by the sufferer's inability to complete simple mathematical processes correctly, to having feelings of nausea and discomfort when confronted by situations involving the manipulation of

numbers, and to shy away from participating in '*things mathematical.*"
A similar scenario can occur in the course of formal education, whether in the primary, secondary, or tertiary arenas. Usually within any group of students a number will be able to learn and fully understand the new concepts being taught at any particular time. On the other hand there will be other members of the group not able to grasp fully the concepts being taught, and who are unable to find the time to master these new concepts before the next topic is introduced. When their understanding of the topic is being examined, formally by means of a test or examination, or informally by questioning around the class, their levels of anxiety will be aroused to such a level that there will be a decline in their performance. They will gain lower than expected marks in the examination or supply a number of incorrect answers to the verbal questioning around the class.

"*Math anxiety is a promising construct for understanding avoidance behaviour in mathematics, particularly in women.*' (Tobias, 1976) The hypothesis is that mathematics anxiety affects mathematics performance and fosters mathematics avoidance, since anxiety '*inhibits work because in order to avoid the anxiety the student will stop studying mathematics.*'

(Tobias and Weissbrod, 1980, page 65)

In the research programme of Dew, Galassi and Galassi (1984) sixty three undergraduates (23 men and 40 women) completed the Mathematics Anxiety Rating Scale (MARS), (Suinn et al 1972), Fennema and Sherman's (1976) Mathematics Anxiety Scale (MAS), Sandman's (1979) Anxiety Towards Mathematics Scale(ATMS) and Spielberger's (1977) Test Anxiety Inventory (TAI) prior to completing three mathematics tasks. Task 1 consisted of 20 arithmetic computation problems randomly selected from the Differential Aptitude Test - Form T (DAT - T), (Psychological Corporation, 1972). Task 2 consisted of 15 word problems that varied widely in difficulty [College Entrance Examination Board (CEEB) and Educational Testing Service (ETS), 1980] and were selected at random from Form 7G027 of the Scholastic Aptitude Test. Task 3 also consisted of 15 word problems administered under test-like conditions. The time allotted for each of these two tests was 15 minutes. The subjects were not informed of the time limit. Task 3 was administered under test-like conditions. These conditions involved telling students that this problem set was a test of their ability, instructing them to do their best but to work rapidly and accurately. They were also informed that there was a time limit of 15 minutes.

The researchers hypothesized that each mathematics anxiety scale score would be significantly correlated with test anxiety and its components. With the exception of the emotionality scale with the ATMS (r = 0.19) and the MAS (r = -0.22) all correlations were significant (r = 0.31 to 0.56) with signs appropriate to the direction in which the scales were scored.

With respect to performance, each of the mathematics anxiety scales was significantly and inversely related to the performance of numerical computations and the word problems in a test-like situation and accounted for 14% to 23% (r = 0.39 to 0.48) of the variance. The researchers also found that the mathematics anxiety measures were more closely related to each other than to test anxiety. The mathematics anxiety measures shared 46.2% - 65.6% variance in common as opposed to 3.6% to 31.3% common variance with test anxiety, suggesting that mathematics and test anxiety are related, but not identical.

Dew, Galassi and Galassi also found that the MARS appears to assess more test related anxiety than the ATMS. Hence, if one is concerned about measuring mathematics anxiety per se, then this tendency in the MARS is not desirable.

Several researchers have shown that mathematics anxiety is inversely and moderately related to mathematics achievement, (Betz, 1978, Brush, 1978). Scores in the Revised Mathematics Anxiety Scale (RMARS) were significantly different between women and men, with the women indicating higher levels of mathematics anxiety than men. As the men in the sample reported having taken approximately the same number of mathematics courses in high school as did the women, it appears that sex differences in mathematics anxiety can be found in students with low levels of mathematics background.

The author, Wither (1987), in his research "*Some Factors Influencing Achievement in Secondary School Mathematics,*" factor analysed the mathematics test anxiety scale derived by Rounds and Hendel (1979). This scale had been assumed to be unidimensional, but two distinct, significant factors were found - a test anxiety factor and a number manipulation factor. Consequent to this finding, Wither has developed a number of mathematics anxiety rating scales, one for each of the school year levels six, seven, eight, nine and ten. These scales have been used in conjunction with the mathematics ability tests 2A, 2B, 3A, 3B as developed by the ACER (Australian Council of Educational Research), and later tests 8A, 8B, 9A, 9B, 10A and 10B developed by the author using, and being fully cognisant of, the syllabuses of Years 8, 9, and 10 school mathematics in South Australia.

In an increasingly technological society, knowledge of mathematics is critical to the pursuit of many existing and emerging occupational fields, (Sells, 1973). In addition to its necessity in scientific and technical fields, knowledge of mathematics is increasingly important in business, the social sciences and humanities (Stent, 1977). In spite of the importance of mathematics however, many intellectually capable students avoid taking mathematics courses in high school and at tertiary level and, consequently restrict the range of careers from which they may choose to those that do not require quantitative skills. Many other students fail to perform to their level of capability in mathematics, and again, do not attain the mathematics knowledge that would expand the range of career options available to them.

One concept being used increasingly to explain both mathematics avoidance and poor mathematics performance is that of *mathematics* *anxiety* (Tobias, 1976).

Because mathematics anxiety is viewed as, in large part, a psychological problem, counselling psychologists are increasingly being called upon to assist in designing and implementing plans for its treatment. Treatment programmes occur in group or individual counselling settings and may include general anxiety management techniques, modification of irrational beliefs or negative attitudes towards mathematics and the development of more positive self-concepts and attitudes.

While there is considerable interest in the treatment of mathematics anxiety, very little is known about the actual prevalence and nature of the problem.

The understanding of mathematics anxiety also necessitates the investigation of its relationships with mathematics ability and with other types of anxiety. For example, research on anxiety correlates of mathematics anxiety would help to clarify both the relative specificity of mathematics anxiety and the extent to which the more general anxiety management procedures may be useful in its treatment.

Betz (1978) designed a research programme to investigate factors related to the prevalence and intensity of mathematics anxiety in college students. It sought to determine the extent to which levels of mathematics anxiety differ as a function of gender, age and prior preparation in mathematics and to investigate the relationships between mathematics anxiety and ability, general anxiety and test anxiety.

BETZ' STUDIES.

Betz found that there were no significant gender differences in mathematics anxiety in the group studying mathematics 2, (a first year mathematics course designed for students planning majors in mathematics or pre-medical courses in which no calculus was involved), but the mean score in this group was higher for females than for males indicating slightly higher levels of anxiety for females. She also found that the relationship between mathematics anxiety and mathematics achievement was negative, of moderate magnitude and statistically significant for both males and females. ($p < 0.001$).

The results of Betz's research indicate that mathematics anxiety occurs relatively frequently among college students in general, but the average levels of mathematics anxiety differ within the various subgroups. It may even be a problem for those students who plan majors and / or careers requiring an extensive mathematics background.

Betz's results correspond to findings by Fennema and Sherman (1977) who found that high school male students generally reported significantly more positive attitudes towards mathematics, including a greater confidence in their ability to learn mathematics, than did high school female students. They also found that high school students in the upper half of the achievement distribution reported more positive attitudes towards mathematics than did students in the lower half.

Betz also found that mathematics anxiety was moderately related in a negative direction to the mathematics achievement test scores (ACT, Mathematics subtest). Thus, higher achievement in mathematics is related to lower reported levels of mathematics anxiety. These results too, are in agreement with the author's previous research investigating the relationship between mathematics anxiety and mathematics achievement.

The relatively high prevalence of mathematics anxiety in the college students studied by Betz also points to increased awareness of mathematics anxiety, by researchers and teachers, as a potential problem area and the need for the development of appropriate treatment methods.

These results have important implications for the process of educational and vocational counselling as students seeking counselling for academic problems may report particular problems with mathematics courses and/or anxiety about their ability to learn mathematics.

Betz carried out research with a group of students taking Mathematics 1, (a first year basic mathematics course offered at Ohio State University), Mathematics 2 (a first year mathematics course for students planning majors in mathematics, or premedical courses in which no calculus was involved) and Psychology 1 (an introductory psychology course for freshmen or sophomores). As a result of this work she concluded that moderately large percentages of students responded in ways suggesting the presence of mathematics anxiety. Overall, females reported significantly higher levels of mathematics anxiety than the males, but this was not so for each of the groups. In the Psychology 1 group, the mean for females differed from that of the males, 29.1 compared with 33.5 for the males at $p < 0.001$, whilst in the Mathematics 1 group the difference between the female and male means was 25.6 compared with 28.9 at $p < 0.01$. Thus in those two groups, the females reported the higher mean levels of mathematics anxiety. No significant gender differences in mathematics anxiety in the Mathematics 2 group were found, but the mean score was higher for the females than for males. The levels of mathematics anxiety were found to be related to both the ages of female students and to the number of years of their high school mathematics background. With respect to the male students the levels of mathematics anxiety was related to the number of years of their high school mathematics background, but not related to age. The correlations between age and mathematics anxiety were -0.29 ($p < 0.01$) for Mathematics 1 females, and -0.17 ($p < 0.05$) for Mathematics 2 females, indicating that in an age range of 17 to 34 the older women reported greater mathematics anxiety than did the younger women. Correlations between age and mathematics anxiety in males and females in Psychology 1 ranged from -0.01 to 0.13 and were not significantly different from zero. Correlations between mathematics anxiety and years of high school mathematics ranged from $r = 0.13$ to $r = 0.43$ and were statistically significant for males and females in all three subject groups. Correlations calculated separately for males and females were not significantly different from each other.

Correlations between mathematics anxiety and Verbal and Mathematics ACT (American College Test) scores showed that the level of mathematics anxiety was not related to the ACT verbal scores, but was moderately related to the ACT Mathematics scores. The correlations between mathematics anxiety and ACT Mathematics scores ranged from 0.17 (Psychology 1 males) to 0.42 (Psychology 1 females). The relationship between mathematics anxiety and achievement was strongest in the Mathematics 2 group where correlations were of moderate magnitude, in the expected negative direction and statistically significant for both males and females.

In the Psychology 1 group, the relationship was significant for females but not for males, and in the Mathematics 1 group correlations were marginally significant for both males and females. Thus, there was a general tendency for higher levels of mathematics anxiety to be associated with lower mathematics achievement test scores.

Betz (1978) concluded that the results of her study indicated that mathematics anxiety occurs relatively frequently among college students in general but that average levels of mathematics anxiety do differ within subgroups of individuals. Betz also concluded that the relatively high prevalence of mathematics anxiety in the college students' studied, strongly suggests the need for an increased awareness of mathematics anxiety as a potential problem area, and for the development of appropriate treatment methods. Moreover, counsellors may wish to be especially attuned to the possibility of mathematics anxiety in students who have had inadequate mathematics backgrounds, and particularly in female students, especially those returning to school in adulthood.

FURTHER STUDIES

Rounds and Hendel (1980) used factor analysis to explore the dimensionality of the Mathematics Anxiety Rating Scale (MARS) of Suinn, Edie, Nicoletti and Spinelli (1972). Their analysis found two factors. The first was termed Mathematics Test Anxiety based on the high loadings associated with the anticipating, and taking of mathematics tests. The second factor, Number Anxiety, deals with practical everyday situations requiring number manipulation, basic arithmetic skills or monetary decisions. Resnick, Viehe and Segal (1982) identified three dimensions in the MARS, two of which, Evaluation Anxiety and Arithmetic Computation Anxiety closely resemble those discussed by Rounds and Hendel (1980). A third factor, Social Responsibility Anxiety, emphasizes items related to the performance of accounting and secretarial duties in clubs and organizations. In both instances the authors conclude that the MARS is a multi dimensional construct and that mathematics anxiety is inextricably linked to the evaluation of mathematical skills.

The moderate degree of relationship between mathematics anxiety and test anxiety also suggests that some students reporting test anxiety may be primarily mathematics anxious and experiencing greater difficulty during mathematics tests. This is another possibility that counsellors may wish to explore and thus focus their treatment of test anxiety on mathematics content and problems. As a result of her study, Sells (1973) strongly suggested that failure to pursue course work in mathematics can severely limit the educational and vocational options of students. Hence, attention to the possible effects of mathematics anxiety would seem to be warranted.

In Sell's (1973) study, examination of response percentages for each of the ten items on the Mathematics Anxiety Scale suggested that mathematics anxiety is a problem for a large number of college students. Consequently, it may be problematic even for those students who plan majors and/or a career requiring an extensive mathematics background.

Findings of greater mathematics anxiety among women than men correspond to the investigations of Fennema and Sherman (1977) who found that high school boys generally reported significantly more positive attitudes towards mathematics, including greater confidence in their ability to learn mathematics than did high school girls. Mathematics anxiety was found to be moderately related to mathematics achievement test scores in a negative direction.

Since many undergraduate degree programmes require students to take at least one mathematics course, highly mathematics anxious students may need support and assistance to achieve their educational goals.
Further study is needed concerning the genesis of mathematics anxiety, its effects on mathematics achievement, participation in mathematics curricula, on career decision making and on effective methods of treatment.

Liebert and Morris (1967) proposed that test anxiety consists of two components, emotionality, behavioural in nature, and conscious worry or concern, a cognitive element. Wine (1971) adopted a purely cognitive orientation. According to her **attentional theory**, test anxious persons divide their attention between task ~ relevant efforts and preoccupations with worry, self-criticism, and somatic concerns. With less attention available for test ~ directed activities, their performance is depressed. These theories all conceptualize an interference model of test anxiety in which test anxiety disturbs the recall of prior learning, thereby degrading performance. An alternative *deficits* model has been proposed by Tobias (1985). This model attributes the low scores of test ~ anxious students to poor study habits and / or deficient test ~ taking skills. Within this model, test anxiety per se, does not cause poor performance. An awareness of poor past performance causes anxiety.

Conflicts within this discussion raise questions. Is test anxiety a cognitive construct or is it behavioural? What is the causal direction in the relationship between test anxiety and performance? In his synthesis of test anxiety research, Hembree (1988), found the construct more behavioural than cognitive in nature. It was seen to cause poor performance, hence the weight of the evidence supported the interference model rather than the deficits model.

No such theoretical base has been constructed for the research of mathematics anxiety (Reyes, 1984). Early in the 1920's, results of the study of mathematics anxiety began to appear, using the methods, procedures and treatments already applied to test anxiety. Most researchers have viewed the two constructs as highly related. Some describe mathematics anxiety as no more than subject ~ specific test anxiety, (Brush, 1981). Others define its content more broadly, including a general dread of mathematics, and of tests in particular. Richardson and Woolfolk (1980), likened mathematics anxiety to a form of test anxiety. They said that attempting to solve a mathematics problem resembled the taking of a test. They also said that mathematics anxious high school and college student reported much of their anxiety in terms of apprehension about their performance on mathematics quizzes and tests.

Richardson and Woolfolk go on to say that mathematics anxiety is something more than, or different from, test anxiety. Mathematics anxiety appears to be a reaction to mathematical content, to some of its distinctive features as an intellectual activity and its connotative meanings for many persons in our society as well as a reaction to the evaluative form of mathematics tests and problem ~ solving activities. The science of mathematics, "being good" at mathematics or liking it connotes

> *certainty, perfection, high intelligence, genius, arcane wisdom, highly specialized knowledge remote from common sense, monotonous and mechanical problem solving, the key to ultimate truth, something*

antagonistic to humanistic values, the essence of practicality, something essentially irrelevant to everyday life, a characteristically masculine activity, or a decidedly unfeminine activity .(In I.G.Sarason, (Ed.), (1972) *Test Anxiety, Theory and Application*, (p. 271)).

However, the cognitive and emotional dynamics of mathematics anxiety are similar to those of test anxiety making it a fruitful area of investigation for researchers, clinicians and educators interested in performance anxieties and their effects upon students' learning and emotional welfare. Wither (1987) in his study of year 10 secondary school students found that the test anxiety and mathematics anxiety correlations were very weak but the relationship between mathematics anxiety and mathematics achievement was moderate, negative in direction and significant ($p \leq 0.001$). On the other hand the relationship between mathematics achievement and test anxiety was very weak with the significance being ($r < 0.01$) .

The nature and extremity of these results make it evident that mathematics and mathematics tests have considerable potential for triggering debilitating emotional arousal. Consequently they invite perfectionism, feelings of inferiority, and intense concerns about social and sexual acceptability, all reliable producers of anxiety and stress.

Richardson and Suinn (1972) and Suinn, et al (1972) report psychometric data on the Mathematics Anxiety Rating Scale (MARS). The MARS is a 98-item scale composed of brief descriptions of ordinary life and academic situations involving the manipulation of numbers or solving mathematics problems that may arouse anxiety. A total mathematics anxiety score is calculated by assigning a value of 1 to 5 corresponding to the level of anxiety checked, with 1 assigned to *'not at all anxious'* and 5 to '*very much anxious*', and then summing all the values.

An internal consistency reliability coefficient, coefficient alpha, calculated from the MARS scores of 397 college students by Richardson and Suinn (1972) was 0.93.

Suinn (1970) reported that over one third of students applying for a behaviour therapy programme to reduce test anxiety indicated that their primary difficulty was connected with mathematics. Suinn and Richardson (1971) found that students requesting assistance specifically for mathematics anxiety scored significantly higher than a control group on the Suinn Test Anxiety Behaviour Scale (STABS) (1969) and at a level comparable to that of students requesting test anxiety treatment. To what extent then, is mathematics anxiety a matter of test anxiety experienced in mathematical situations? Do feelings of apprehension about, and aversion to, mathematics concern anything more or different from fear of evaluative or test ~ taking situations involving numbers and mathematics.

Brush (1976) found a strong positive relationship ($r = 65$, $p < 0.001$) between STABS and MARS total scores in a sample of 80 university students, 48 females and 32 males. But when the students were divided into approximately equal groups of Physical Science, Social Science and Humanities majors, it was found that although the mean STABS group scores were virtually identical, the groups differed significantly on the MARS ($F(2,74) = 5.63$, $p < 0.01$). Physical science majors showed the least and humanities majors the most mathematics anxiety.

Often, reviews of test anxiety contain a section that explicitly considers mathematics anxiety (Tryon, 1980). A tacit belief seems to prevail that test ~ anxiety theory can be used to support both constructs.

Despite its lack of independent identity, the research of mathematics anxiety has flourished, spurred on by increasing perceptions that the construct threatens both achievement and participation in mathematics. These suggestions have national importance; when otherwise capable students avoid the study of mathematics, their options regarding careers are reduced, eroding the country's resource base in science and technology.

The Current Study

In the light of these concerns, it seems wise to challenge the prior assumptions and develop a scholarly base for the anxiety construct, ensuring that treatments towards its relief are compatible with its nature. Existing research can now be used for this effort.

The present study was thus conceived with comprehensive intentions to:

◊ Help build theories.

◊ Examine effects.

◊ Compare descriptions for treatment.

◊ Describe the construct as fully as the mass of research will allow.

In this longitudinal study four questions were raised.

◊ *Is mathematics anxiety present at year six level in the primary school mathematics class?*

◊ *If it is present, is this anxiety moderate to strong and significant at this level?*

◊ *Is it present throughout years seven, eight and nine? [The author has established that anxiety is an influencing factor with respect to achievement in year ten mathematics, (Wither, 1987)].*

◊ *Are the correlations between achievement and anxiety meaningful with respect to year levels six to ten throughout this five-year period?*

◊ *Is there a preponderance of causation during this period?*

The hypotheses put forward in order to determine the answers to the four questions are:

◊ *Mathematics anxiety exists at a meaningful and significant level at year 6 through to year 10.*

◊ *The correlations between mathematics anxiety and mathematics achievement are meaningful, significant and in the negative direction at each semester from year 6 to year 10.*

◊ *The preponderance of achievement over anxiety is measurable at meaningful and significant levels throughout years 6 to 10.*

In summary, is anxiety present throughout school years 6 to 10? Is it measurable and has it a meaningful relationship with achievement? Is there an interactive relationship between achievement in mathematics and anxiety in mathematics? Furthermore, either anxiety causes lack of achievement or lack of achievement causes an increase in anxiety.

To achieve these objectives four tasks were defined. Task 1 set out to identify the variables that constitute the anxiety construct. Task 2 was to identify variables that correlate with the construct. Task 3 investigated the relationship between mathematics anxiety and mathematics performance over time. Task 4 examined treatments to reduce mathematics anxiety, to (a) compare their relative degrees of mathematics anxiety reduction and (b) determine if the treatments affected performance. Fulfilment of these four tasks would allow for a probing of issues related to theory.

Chapter 4

THE PILOT STUDY

Introduction

In this chapter the purpose, subjects and instruments of the pilot study will be detailed. The development of the mathematics achievement test and the mathematics anxiety scale will be discussed; details of the application of the test and the scale will be given; the results of the pilot study and the interpretation of the results and suggestions for any future studies will also be considered.

Purpose

The purpose of the pilot study was to explore the properties of the mathematics achievement test and the mathematics anxiety scale. The subjects for this analysis were year 6 students from five schools within the

Adelaide metropolitan area. Four of the schools were co-educational and the fifth was a single sex girls' school.

The conducting of the pilot study enabled the checking of the wording of the individual items in the achievement test and the anxiety scale for ambiguity and appropriate level of language understood by year 6, ten year old, students.

The mathematics achievement test was developed 'ab initio' by the author from a number of the Year 6 mathematics text books in use in South Australian Schools during 1989. Experienced primary school teachers, familiar with the content of year six mathematics, scrutinized all of the questions and their comments regarding content and wording were used to improve the original draft of the test booklet. The mathematics anxiety scale was adapted for the year 6 students from an earlier year 10 scale produced by the author (1987), which in turn had been adapted and greatly modified from the original mathematics anxiety scale of Rounds and Hendel (1980). The Rounds and Hendel anxiety scale was prepared for American University students. To my knowledge there were no mathematics anxiety scales available for use with primary school students within Australia.

Given the importance of obtaining a valid and reliable measure of mathematics anxiety, a major objective of the pilot study was to establish the suitability of this test at year six level and therefore to enable its use again in the first year of the major study. The students' responses to the anxiety scale were analysed using the Statistical Package for the Social Sciences (SPSSX) on a UNIX computer.

Cluster analysis was performed on the anxiety scale in order to establish the existence of one or more groupings in the scale. Had one of these groupings been deemed to pertain to *test anxiety* then the items contained in this grouping would have been replaced by items referring specifically to mathematics anxiety. It was the intention that this anxiety scale be used in the first year of the major study, and as such it should contain only items relating to mathematics anxiety.

A second purpose of conducting the pilot study was to determine whether a relationship existed between mathematics anxiety and mathematics achievement and whether it was at a significant level at year six.

A third purpose of the pilot study with respect to the mathematics achievement test and the mathematics anxiety scale was to establish the requirements for the administration, delivery and processing of the tests for the major study.

Method

One hundred and forty-nine year 6 students from five Adelaide Metropolitan primary schools participated in the pilot study - 43 boys and 106 girls. This information is shown in **Table 6**.

Table 6

School and Composition of Year 6 Classes participating in the Pilot Study.

School	Male	Female	Total
A	4	11	15
B	13	15	28
C	19	18	37
D	7	21	28
E	-	41	41
Total	43	106	149

As can be seen from **Table 6**, four of the schools were co-educational, the fifth being an all girls school. Three of the co-educational schools were part of the South Australian Public Schools system, the remaining co-educational school was within the South Australian Catholic Schools system. The single sex school was a member of the South Australian Independent Schools Board. The five schools were within the metropolitan area of the city of Adelaide, chosen at random within the bounds of convenience. The students at year 6 level are approximately 10 years old.

The tests were carried out towards the end of second term 1989. At this period in the academic year the mathematical knowledge required for the forty item test had been covered in the classrooms of the participating schools.

Prior to the testing, the purposes of the mathematics achievement test and the mathematics anxiety scale were explained to each of the mathematics teachers of the pupils in the classes involved. It was explained that the mathematics achievement test was designed to be a measure of the respondents' level of competence in mathematics at year 6 level; that the mathematics anxiety scale should give an indication of the extent of the students' anxiety towards testing in mathematics and the manipulation of numbers. The members of staff were also informed of the nature of the Likert (1932) method of attitude measurement. The procedure involved the researcher selecting a set of attitude statements, for each of which he asks subjects to indicate their agreement or disagreement along a five-point scale ranging from '*worries me an awful lot*' to '*does not worry me at all*'. It was assumed that all subjects would perceive "*worries me an awful lot*" as being less favourable towards the attitude statement than " *worries me a little*" and "*does not worry me at all*" . The subject's score was to be tabulated by assigning a numerical value to each of the answers, ranging from 4 for the alternative at one end of the scale to 0 for the alternative at the other, and then summing the numerical values to the answers to all of the statements.

It was also explained that the purpose of the pilot study was to analyse the mathematical achievement test and the mathematics anxiety scale to see if they did in fact serve their purpose, and if so, then they could be said to be valid and suitable tests. If the analysis showed that the tests were not suitable, then the items which were not suitable would, after further inspection, be replaced and another pilot study might have to be conducted.

When the mathematics achievement test had been handed out to each student the instructions on the first page of the test were read out and the students were then asked if they understood the instructions or if they had any questions appertaining to these instructions. It was explained to them that each question had five answers, one of which was correct. Their preferred answer was to be indicated by marking a circle around A, B, C, D or E on the separate answer sheet. The question paper was *not* to be marked. The students were also told that the achievement test contained forty items relating to their work in mathematics at year six levels.

After the distribution of the mathematics anxiety scale the instructions concerning this scale were also read out to the students. They were informed about the scale and its associated Likert type-marking scheme. They were told that the scale was an attitude scale, that is, the scale was trying to ascertain their level of anxiety towards mathematics and mathematics problems. There was no right or wrong answer, just how they felt about each of the statements. They were to read each statement carefully and decide how they felt about it.

- If it '*doesn't worry me at all*', circle 0
- If it '*worries me a little*', circle 1
- If it '*worries me a fair amount*' , circle 2
- If it '*worries me a lot*', circle 3

- If it '*worries me an awful lot*', circle 4.

There was no time limit for this anxiety scale, but the students were asked to work through it as quickly as possible.
There was to be no talking, moving around, copying or leaving the classroom for the duration of the testing. The students indicated that they understood these instructions.

At this stage the timing of the tests began. These times were recorded and would be used in the major study testing. The time required to complete the mathematics achievement test was 60 minutes, the mathematics anxiety scale required 20 minutes, and there was a 10-minute interval between the two tests. Allowing for an additional 10 minutes explanation time of the requirements of each of the mathematics achievement test and the mathematics anxiety scale, the total time taken was 110 minutes.

Results

The mean scores of each of the participating schools in the mathematics achievement tests and the mathematics anxiety scale are shown in **Table 7**.

Table 7

Mean scores of the Participating Schools in the Mathematics Achievement Test and Mathematics Anxiety Scale.

	School				
	A	**B**	**C**	**D**	**E**
Achievement	31.0	35.7	42.3	41.4	42.4
Anxiety	15.0	24.5	20.9	20.3	21.3
Number (n)	15	28	37	28	41

The mean scores of the mathematics anxiety scale were all below the 25% mark. However the overall histogram of the mathematics anxiety scale showed that anxiety levels ranged from a very low 2% to a very high level of 83%. The histogram is shown in **Table 8**.

Table 8

Histogram of Scores Obtained

in the

Mathematics Anxiety Scale

Count	Range	
13	0 - 4	*************
10	5 - 8	**********
29	9 - 12	*****************************
22	13 - 16	**********************
13	17 – 2 0	*************
16	21 – 24	****************
9	25 – 28	*********
10	29 – 32	**********
7	33 – 36	*******
3	37 – 40	***
5	41 – 44	*****
4	45 – 48	****
2	49 – 52	**
3	53 – 56	***
0	57 – 60	
2	61 – 64	**
0	65 – 68	
0	69 – 72	
0	73 – 76	
0	77 – 80	
1	81 - 84	*

Mean	21.24	Mode	10.11	Std. Dev.	14.61
Skewness	1.32	Minimum	2.00	Maximum	84.00

The histogram showing the results of the mathematics achievement test is shown in **Table 9**.

Table 9

Histogram of the Results

of the

Mathematics Achievement Test

Count	Range	
4	0 - 15	****
3	16 - 18	***
5	19 - 21	*****
6	22 – 24	******
9	25 – 27	*********
17	28 – 30	*****************
9	31 – 33	*********
18	34 – 36	******************
8	37 – 39	********
12	40 – 42	************
9	43 – 45	*********
11	46 – 48	***********
7	49 – 51	*******
6	52 – 54	******
7	55 – 57	*******
4	58 –60	****
4	61 –63	****
3	64 –66	***
2	67 –69	**
1	70 –73	*
4	73 - 76	****

Mean	39.53	Mode	35.00	Std.Dev	14.11
Skewness	0.43	Minimum	12.00	Maximum	75.00

As the mean score was 39.53% the test may have been deemed too difficult for the majority of the students. Only 31 students gained higher than 50%.

The mean mark and the standard deviation of the male and female results in the mathematics achievement test and the mathematics anxiety scale are shown in **Tables 10a** and **10b**.

Table 10a

Mathematics Achievement Test Showing Mean Scores and Standard Deviation Score of Males and Females.

Gender	Number	Mean	Standard Deviation
male	43	42.73	14.29
female	106	38.23	13.90

Table 10b

Mathematics Anxiety Scale Showing Mean Scores and Standard Deviation Score of Males and Females.

Gender	Number	Mean	Standard Deviation
male	43	19.35	12.41
female	106	22.00	15.39

The Spearman Rank Correlation coefficients between the mathematics achievement test results and the mathematics anxiety scale results were calculated and the results are tabulated in **Table 11.**

Table 11

Spearman Rank Correlation Coefficient Between the Mathematics Achievement Test and the Mathematics Anxiety Scale.

Group	Correlation (r)
Entire	- 0.30 **
Male	- 0.34**
Female	- 0.28 *
School 'A'	- 0.05
School 'B'	- 0.14
School 'C'	- 0.75 **
School 'D'	- 0.30**
School 'E'	- 0.34**

* $0.001 < p < 0.01$. ** $p \leq 0.001$.

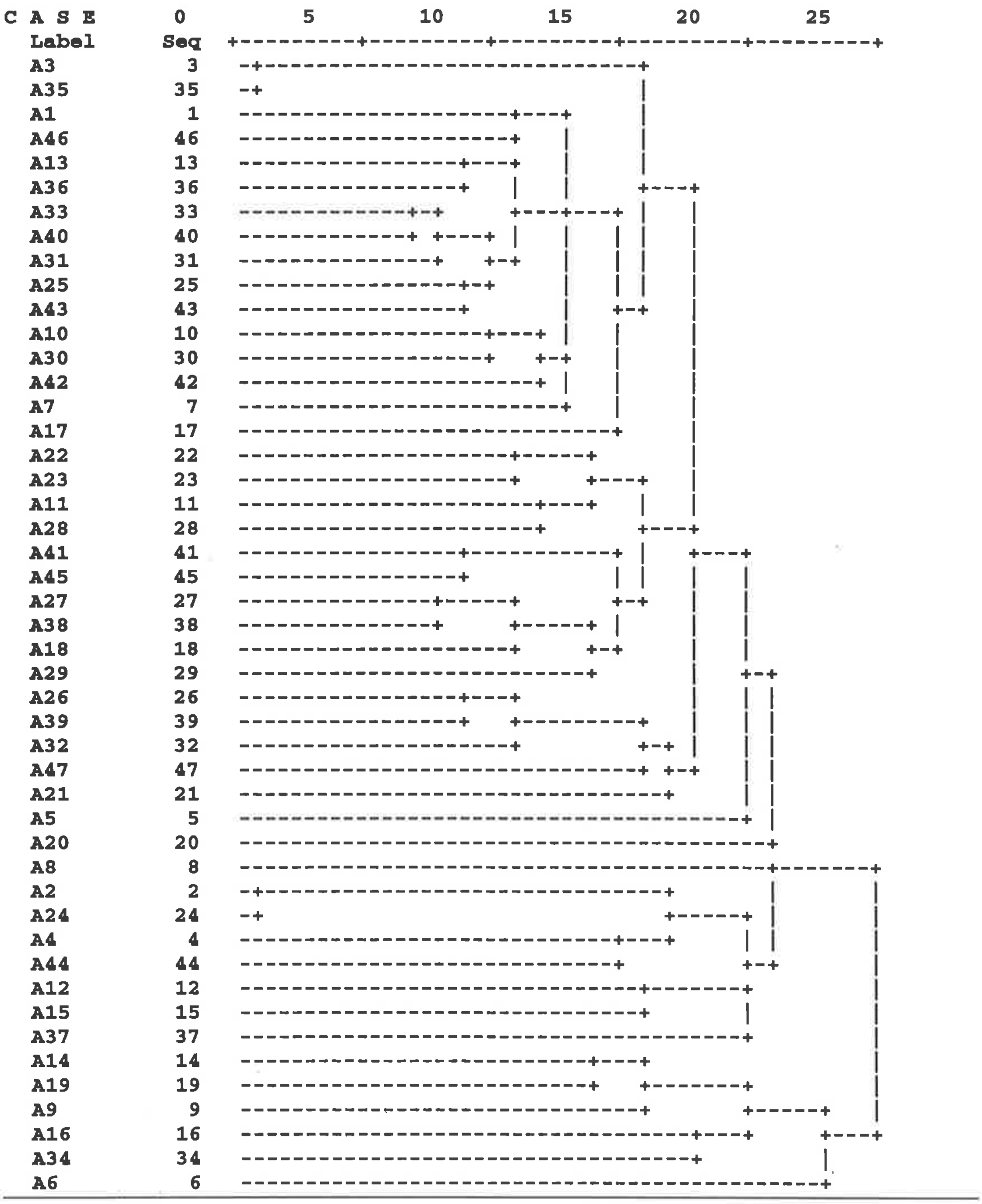
The correlations between mathematics achievement and mathematics anxiety were all in the negative direction showing that any increase in the scores gained in the one would result in a decrease in the scores obtained in the other. In other words, an increase in the level of a student's mathematics anxiety would be expected to be associated with a decline in the level of achievement in mathematics by that student, or an increase in achievement would be expected to be associated with a decrease in anxiety. For the entire group of students, a change in the level of mathematics anxiety would result in a change in the level of mathematics achievement, and 9% of this change could be attributed directly to the change in the students' level of mathematics anxiety. Similarly, for the male group of students, a change in the level of mathematics anxiety would result in a change in the student's level of mathematics and 11.5% of this change could be directly attributed to the change in the student's level of mathematics anxiety. The percentage change attributed to mathematics anxiety for the female group of students was slightly lower, being 7.8% whilst the percentage change with respect to the students of school 'C' was 56.25%

Cluster analysis of the mathematics anxiety scale showed that there were two clusters within the test. The dendrogram of their analysis is shown in **Table 12.**

Last paragraph -Reference the dendrogram - the group from A14 to A6 is shown by the dendrogram to be separated from the group of all the others by a distance of approximately 25 units. (Note the points to the far left of A16 and A8).

Table 12.

The Dendrogram of the Mathematics Anxiety Scale.



Closer analysis of the scale indicated that only six items were not closely related to any other item. These items are shown in the **Table 13**.

Table 13.

Items Not Closely Related to Another Item Within the Mathematics Anxiety Scale.

Item Number	Item Name
14	A test the next lesson
19	A test next day
9	A test next week
16	Dividing by decimals
34	Simplifying fractions
6	Having to explain a mathematics problem in front of Class.

As can be seen from the dendrogram of the rescaled distance cluster of the mathematics anxiety scale, the forty five items of the test would seem to correlate closely together into two groups. The items in the larger grouping were examined. All were statements dealing with specific areas of mathematics. These items were retained for use in the first year of the major study. The smaller group contained items 6, 9, 14, 16, 19 and 34 and these are listed in **Table 13.** Items 6, 9, 14 and 19 refer specifically to "test" situations. As a result these were not included in the anxiety scale used in the first year of the major study. Items 16 and

34 refer to the use of mathematical knowledge and were retained for use in the anxiety scale of the main study.

The dendrogram of the mathematics achievement test is shown in **Table 14.**

Analysis of the rescaled distance cluster combine did seem to indicate two distinct clusters in the mathematics achievement test. However, closer inspection of items 8, 10, 11, 26, 29 and 36 did not reveal any distinct difference between these six items and the remaining thirty-four items. Consequently it was decided to leave the year six mathematics achievement test in its original form.

Table 14

Dendrogram of the Mathematics Achievement Test.

```
C A S E        0         5        10        15        20        25
  Label       Seq  +---------+---------+---------+---------+---------+
  MK13         17   -+-+
  MK23         20   -+ +-+
  MK27         32   ---+ +-----+
  MK14         37   -----+     |
  MK39         40   -----+     +-+
  MK34         12   -----------+ +-+
  MK28          6   -----------+ | |
  MK8           1   -------------+ +---+
  MK25         21   -------+-+     |   |
  MK5          34   -------+ +-----+   |
  MK32         23   ---------+         +-+
  MK16         30   -------------------+ |
  MK20          4   -------------------+ |
  MK33         33   -----------------+-+ |
  MK19         38   -----------------+ +-+-+
  MK4          28   -------------------+ | |
  MK18         19   ---------------------+ +-+
  MK10         35   -----------------------+ +-+
  MK17          3   -----------------------+ | |
  MK26          5   -------------------------+ |
  MK2           7   -------------------------+-+-----+
  MK15         18   -------------------------+ |     |
  MK36         24   ---------------------------+     +-+
  MK37         14   ---------------------+---------+ | |
  MK21         31   ---------------------+         +-+ |
  MK35         13   ---------------------------+---+   |
  MK30         22   ---------------------------+       |
  MK38         15   -----------------------+-------+   |
  MK9          16   -----------------------+       +---+-------------+
  MK11          2    -----------------------+---+   |   |             |
  MK31         39    -----------------------+   +---+   |             |
  MK22          9    ---------------------------+       |             |
  MK40         25    ---------------------------+-------+             |
  MK3          27    ---------------------------+                     |
  MK29         11     ----+-+                                         |
  MK1          26    -----+ +---+                                     |
  MK12         36    -------+   +---+                                 |
  MK6           8    -----------+   +---------+                       |
  MK24         10    ---------------+         +-----------------------+
  MK7          29    -------------------------+
```

The six items not closely related to the other items within the mathematics achievement test are shown in **Table 15**.

Table 15

Item number	Item name
8	Using the rule of BODMAS
10	Finding the distance travelled round a box
11	Carrying out long division
26	Finding the diagonals of a rectangular box
29	Estimating the change when shopping
36	Calculating distance in cm.

To establish the internal consistency reliability of the mathematics achievement test and the mathematics anxiety scale the Cronbach Alpha Reliability Index was used.

The results are shown in **Table 16.**

Table 16

Cronbach Alpha Reliability Coefficients of the Achievement Test and the Anxiety Scale.

Test	Alpha
achievement test	0.77**
anxiety scale	0.96**

** $p \leq 0.001$

As can be seen from the table, the Cronbach Reliability Index for the mathematics achievement test indicates an internal consistency of 0.77 whilst the same index measuring the mathematics anxiety scale recorded a consistency of 0.96. The maximum consistency level possible is 1. Researchers in the Social Sciences accept that an instrument is deemed reliable provided the Cronbach Alpha is > 0.60. As the coefficients are greater than this ascribed level, the test and the scale can be said to be reliable instruments.

Conclusions

The results of the pilot study established that the tests were reliable and that mathematics anxiety did exist at year six and that the level of anxiety was significant. One exception was found in the case of the school in the lower socio-economic scale. The principal of the school intimated that most of the students would have been far more concerned about basic needs like food or the whereabouts of their parents when they would arrive home from school rather than how they might have performed in a mathematics class held during the day or how they might perform in a test due the following day.

The content of the two tests seemed to be appropriate for the year level for which they were intended and the timing of the tests also seemed to be correct indicating that the length of the tests was appropriate for this level of school student.

The main study was scheduled to be carried out the following year with students at year six level from three metropolitan schools in Adelaide. As the study was of a longitudinal nature the schools were chosen because their students were most likely to stay together within the school as they progressed from year six through to year ten. In many other schools the students stay together during years six and seven but go off in different directions as they move into their senior school education. In other words, the students do not remain within the umbrella of a single school structure as they pass from their primary education to their junior secondary school education. Because of the nature of this system, there was still a large influx of students attending the three schools at year 8.

Suggestions for Future Studies

The requirements for the administration, delivery and processing of the achievement test and the anxiety scale, the cluster analyses and the correlations between the two sets of tests showed that they were suitable instruments by which the relationship between achievement and anxiety can be gauged at year six level. The two tests may be used in tandem, but each can be used separately to assess respectively either the student's level of understanding of mathematics or the level of anxiety being experienced at that time. Results of either or both instruments may form the starting point from which the mathematics teacher or school counsellor can determine whether high anxiety is present, or whether low achievement is being manifest, and consequently a programme of study can be prepared to alleviate or eliminate the problems.

Chapter 5

Results of the

Mathematics Achievement Tests 6A – 10B

and

the Mathematics Anxiety Scales 6A – 10B

All year six students attending the three schools participating in the longitudinal study undertook the Mathematics Achievement Test 6A (see Appendix C) and the Mathematics Anxiety Scale 6A(see Appendix D) during the first semester and Test 6B and Scale 6B during the second semester. In the following year the same students participated in the Mathematics Tests 7A and 7B and the Mathematics Anxiety Scales 7A and 7B. This pattern continued until the students had completed their year ten education. A number of students were not able to complete all of the tests and questionnaires during this five-year period. Only 66 students participated in all of the tests and scales. The calendar years and semesters of the administration of the programme is set out in **Table 17**.

Table 17

Year and Semester of Administration of the Achievement Tests and Anxiety Scales.

Year	Semester 1 Test/Scale	Semester 2 Test/Scale
Year 6 (1990)	6A	6B
Year 7 (1991)	7A	7B
Year 8 (1992)	8A	8B
Year 9 (1993)	9A	9B
Year 10 (1994)	10A	10B

Each set of ten achievement tests and anxiety scales were given to the same students as they progressed from year 6 in the preparatory school through to year 10 of their secondary education.

The achievement tests 6A, 6B, 7A and 7B used in this longitudinal study were developed and produced by the Australian Council for Educational Research. These Progressive Achievement Tests in Mathematics (PATMATHS) were intended for use in Australian schools to assist teachers in determining the level of achievement attained by their students in the basic skills and understanding of mathematics.

The PATMATHS series consisted of three tests at different levels of difficulty. All of the items were in multiple choice format and each test contained a range of general mathematics topics. Each test required forty-five minutes of testing time plus time for administration. There were two equivalent forms of each test. The tests were designed for administration at the following school year levels:

Test 1, Years 3, 4 and 5

Test 2, Year 5, 6, 7 and 8

Test 3, Years 6, 7 and 8.

The number of items in Test 1 was 47, in Test 2, 57 and in Test 3, 55.

Within the tests the items were arranged in content groups, and within each content group the items were ordered from easiest to most difficult. There were two equivalent forms at each test level, called A and B. Test 1A and Test 1B were not used in this longitudinal study as these tests were designed for students who had not reached year 6 level.

Table 18 shows the area contents of tests 2A and 2B, 3A and 3B.

Table 18

ACER Patmaths Tests: Content Area Structures of the Tests

Topic	Item Numbers	
	2A or 2B	3A or 3B
Number	1 - 10	1-10
Computation	11-20	11-20
Fractions	21-27	-
Measurement and Money	28-37	21-30
Statistics and Graphs	38-42	31-35
Spatial Relations	43-52	36-45
Relations and Functions	-	46-50
Logic and Sets	53-57	51-55

The ACER advised that the level 3 tests should be used only with advanced Year 6 classes (Teachers Handbook, p.1). The students participating in the longitudinal study were not selected for their mathematics ability - they were students at year six level throughout 1990 in the three participating schools. Hence tests 2A and 2B were administered to these year six students, test 2A towards the end of the first semester and test 2B towards the end of the second semester. For ease of recording purposes, test 2A was renamed 6A and test 2B was renamed 6B; test 3A became test 7A and 3B became 7B.

All tests from year 6 to year 10 used the same answer sheet, but the scoring keys differed for each semester test.

As there were no equivalent ACER tests available, tests 8A through to 10B were prepared by the author (Wither) in consultation with six practising teachers. Each of whom had many years of experience, throughout the secondary levels of teaching and during the length of the project were teaching at levels 8, 9 and 10. Prior to each testing period, each of these teachers was in receipt of the proposed tests. They were asked to comment on the suitability of each question, the suitable positioning of each question in so far that the easier questions were at the beginning of each topic section, and to inform the author if any question was outside the current mathematics curriculum for that particular year. They were also asked to indicate whether a question, or a topic, was taught during the first semester or during the second semester. Should any one school not teach a particular topic until the second half of the year, then any questions relating to that topic would not be included in the first semester tests. The teachers were asked to check the wording of each question as to suitability and possible ambiguity, and to ascertain that only one of the five multiple choice answers to each question was correct. They also checked for any repeated questions in each paper.

The format of the tests 8A to 10B was very similar to the format established in the ACER Patmaths tests for years 6 and 7. In the tests 8A to 10B the topics included in the paper were Algebra, Computation, Geometry, Graphs, Indices, Irrational Numbers, Logic, Money, Number and Ratios. The number of questions in the tests 8A, 8B, 9A, 9B, 10A and 10B were 52, 55, 54, 55, 55 and 43 respectively. The time allowed for the completion of tests 8A, 8B, and 9A was 45 minutes. 60 minutes was allocated for the tests 9B, 10A and 10B.

All test papers are included in Appendix C.

The number of students participating in this longitudinal research project is shown in **Table 19**.

Table 19

Number of Students Participating in the Mathematics Achievement Test 6A to Test 10B.

Year	Test A Semester 1	Test B Semester 2
6	156	167
7	183	187
8	289	279
9	274	272
10	261	200*

*School A had completed the formal part of its teaching programme and their students were unavailable for test 10B

Year 7 is the final year of a student's primary education within the Education Department schools, and in some non-Department schools in South Australia. Hence, students entering year 8 to commence their first year of secondary education not only move into a new environment, but, in many cases, enter a new school and a new system of education. Many parents, at the end of year 7, whose children attended primary schools under the auspices of the State Education Department, send them to private schools for their secondary education.

This impacts on the three schools involved in this study. Each one has its own junior school, but there is a large intake of students from other primary schools who join the students in the secondary part of the school, swelling their year 8 numbers as shown in the table.

The numbers are not stable even within each year, as seen in the differences between the numbers participating in the first semester test A and the second semester test B, and certainly not from year to year. In all, of the 268 different students tested over the five years, only 66 completed all the tests.

Conduct of the Achievement Test and the Anxiety Scale

A standard format was adopted for the format of each test. Immediately prior to commencement a question paper and an answer sheet was placed on each student's desk.

The test was then conducted by the teachers of the students. They instructed the students to put their name, class and school on each answer sheet. They read very carefully the instructions to be followed for the test, they allowed time for any questions relating to the instructions to be followed, and the students were told that this was a test and therefore no talking, copying, or moving around was permitted. The students were also informed of the time allowed for the test.

Results of the Achievement Tests

The histograms of the results of the achievement tests undertaken by the students from semester one, year 6 to semester two, year 10 are reproduced in **tables 41 - 70** in Appendix A. **Tables 41 - 50** depict the first and second semester results for the entire group of students who participated in the longitudinal study. **Tables 51 - 60** show the results of all of the male students participating in the project and **tables 61 - 70** illustrate the achievements of all of the female students.

Each of the histograms shows a degree of skewness ($-1 < \text{skewness} < 1$) which indicates that the scores can be taken to be likened to a normal distribution throughout the period of this five year study. Eight of the histograms have a negative degree of skewness, the other twenty two histograms are all positively skewed.

The number of students participating in the achievement tests ranged from a maximum of 289 in the first semester of year 8 to a minimum of 156 students in semester one, year 6. The number of male students ranged from a maximum of 142 in semester one, year 8 to a minimum of 84 in semester one, year 6. Comparable numbers of female students ranged from a maximum of 152 in semester one, year 9 to a low of 71 in semester one, year 6. Throughout the study the number of males was generally equal to the number of females.

Tables 41 – 50 show the results of the achievement tests of the entire group of students. As the histograms of the results show an almost normal distribution with almost 68% of the students gaining marks within plus or minus one standard deviation from the mean score. In six of the tests, the mean scores were greater than, or equal to, 40% indicating that the tests were of a standard generally accepted as not too difficult for the majority of the students. Overall the maximum scores ranged from 83.33% (test 9A) to 100% (test 10B) and minimum scores ranged from 0% (test 6B) to 1.82% (test 7A).

Tables 51 - 60 show the histograms of the results of all of the male students. Comparison of the range of results from the first achievement

Reference last paragraph:

Summary of Mathematics Achievement Tests

Test	Mean	Standard Deviation
6A	52.63	18.27
6B	54.14	17.57
7A	34.64	14.46
7B	37.31	18.00
8A	44.28	16.12
8B	52.65	21.08
9A	39.55	15.81
9B	36.88	17.19
10A	37.82	11.98
10B	42.41	17.84

test at semester one, year 6 until the last test at semester two Year 10 reveals that all of the histograms were only slightly skewed from the normal distribution. The skewness varied from – 0.21 to 0.77. The maximum scores ranged from 81.82% (7B) to 100% (10B) and the minimum scores fell between 0% (6B) and 14.35% (10B). However, these ranges of score apply to nine of the ten tests. The semester one, year 7 maximum results were much lower. A reason for this discrepancy has not been forthcoming.

From **Tables 61-70** it can be seen that in nine of the achievement test scores of the female students the minimum score obtained was somewhat higher than the comparable scores of the male students and their maximum scores were very similar to those of their male counterparts. Thus, the range of scores was narrower for the female students. Also, the scores of the female students were quite uniform either side of the mean scores throughout the testing period.

The highest mean score was 55.03% (Test, 6B), and the lowest recorded score was 37.72%(Test 7A), with the standard deviation ranging from a high of 21.04% (Test 6A) to a low of 13.46% (Test 10A). The Inter Quartile Range (IQR) of the scores of the ten achievement tests varied between $22.5 \leq IQR \leq 62.5$ (Test 9B) and $33.5 \leq IQR \leq 73.5$ for Test 8B. Thus fifty percent of the students gained marks ranging from a low of 22.5% (Test 9B) to a high of 73.5% (Test 8B) and 21.04 (Test 6A)

Results of the Anxiety Scales

The histograms of the results of the anxiety scales undertaken by the students are reproduced in **Tables 71 - 100** in appendix A. **Tables 71 - 80** show the results of all of the students in years 6 to 10. **Tables 81 - 90** show the results for all of the male students in years 6 to 10 and **Tables 91 - 100** show the results for the female students.

All of the histograms were positively skewed, the degree of skewness ranging from a low of 0.27 (males, semester 1, year 8) to a high of 13.94 (males, semester 2, year 7). The skewness was in the expected direction, confirming that there were only a small number of students in these mathematics classes who suffer from moderate to severe levels of anxiety.

The number of students participating in the study ranged from 183 in year 6, semester 1 to 268 in year 8, semester 2. The number of male students

Reference second paragraph:

Summary of Mathematics Anxiety Scales

Scale	Mean	Standard Deviation
6A	16.14	12.87
6B	20.81	14.58
7A	13.76	11.92
7B	10.11	12.20
8A	14.56	18.68
8B	11.63	12.69
9A	15.05	15.21
9B	12.45	11.85
10A	14.83	12.06
10B	14.56	12.06

ranged from 88 in year 6, semester 1, to 142 in year 8, semester 1. There were 71 female students participating in year 6, semester 1, the number increasing to 152 in year 9, semester 1.

Analysis of **Tables of Histograms 71 - 80** indicated that 16% of all students had an anxiety level of 25% ($\bar{x} + 1\sigma$) or greater. The male students' results are shown in **Tables 81 – 90**. ($\bar{x} + 1\sigma$) - means "one standard deviation above the mean".

In every semester test there was a long tail on the histogram of the results. There was always a number of students who recorded a very high level of anxiety.

The female students' results are shown in **Tables 91 - 100**. 16% of these particular students experienced an anxiety level greater than 34%. All of the histograms showed a degree of skewness ranging from 0.84 (semester2, year 10) to 2.97 (semester 1, year 8). All were positive indicating that there were relatively few students experiencing high levels of anxiety towards mathematics.

The histograms of the achievement tests and the anxiety scales illustrated very clearly the achievement and anxiety levels of all of the students participating in this longitudinal study.

The following chapter uses the results of these students to examine the relationship between achievement and anxiety during each semester throughout the five-year period.

Chapter 6

The Correlations Between Mathematics Achievement and Mathematics Anxiety.

Introduction.

In this chapter the relationship between mathematics anxiety and mathematics achievement is determined and analysed. The relationship was established, in this study, using the Spearman rank correlation technique in which the results of the concurrent achievement tests and the anxiety scales, are compared. The relationship between the two items may range from –1 to 1.

The Spearman correlation was used in preference to the more usual Pearson correlation because the anxiety scale was not normally distributed.

Six separate sets of correlations were prepared for analysis. The first set contained the results of the correlations of achievement and anxiety of the entire population of students as they progressed from year six through to year ten. The second set of results appertained to all of the male students participating in the longitudinal study and the third group's results were those of the female students taking part in the study. The fourth, fifth and sixth groups of results are those obtained by each of the three schools during each semester of the five-year study. Each analysis was carried out twice during each of the five years of the duration of the research project - once during the first semester of each year, and again towards the end of the second semester of each year.

The number of students participating in the longitudinal study varied from semester to semester throughout the study. During years 6 and 7 there were between 150 and 190 students involved in the project. In years 8 to 10 the number of students increased considerably, the numbers ranging from 240 to 280, except that in the second semester of year 10 the number of students participating dropped to about 160.

For the same reasons noted in chapter 4 there was a large increase in numbers between school years 7 and 8. At year 8 all students begin their secondary education. It is at this time that most students in the State school system must change schools as there are only a small number of R to 12 schools. With a choice to be made, many parents elect to take their child out of the State school system to enrol in a private school. In the case of the three non-government schools participating in this study student numbers were boosted by these moves.

The drop in the number of students participating during the second semester of year 10 was owing to the year 10 students not being available at one of the participating schools, having completed their formal lessons by the time the tests were scheduled.

The number of male students taking part in the project ranged from 84 in year 6, semester one, to 142 in year 8, semester one. In comparison, the number of female students taking part ranged from 72 in year 6, semester one, to 152 in year 9, semester one.

When comparing the number of male and female students participating in each of the semester tests, it can be seen that the number of males is slightly greater in year 6. The numbers are almost identical in year 7, male numbers slightly less in year 8 and the number of females greater in years 9 and 10 (semester 1).

Table 20

The Correlations Between Concurrent Achievement Tests and Anxiety Scales

Test	Correlation (Number of students)					
	Entire	Male	Female	School A	School B	School C
6A	- 0.49** (156)	- 0.51** (84)	- 0.41** (72)	- 0.39** (63)	- 0.57** (51)	- 0.45** (42)
6B	- 0.43** (167)	- 0.31* (88)	- 0.57** (79)	- 0.47** (72)	- 0.39* (52)	- 0.40* (43)
7A	- 0.50** (183)	- 0.52** (91)	- 0.46** (92)	- 0.44** (79)	- 0.70** (50)	- 0.41* (54)
7B	- 0.34** (187)	- 0.28* (95)	- 0.40** (92)	- 0.31 (86)	- 0.51** (49)	- 0.61** (52)
8A	- 0.23** (289)	- 0.24* (142)	- 0.21 (147)	- 0.12 (145)	- 0.57** (72)	-0.45** (72)
8B	- 0.40** (268)	- 0.33** (132)	- 0.46** (136)	- 0.37** (124)	- 0.41** (72)	- 0.53** (72)
9A	- 0.49** (263)	- 0.51** (110)	- 0.45** (153)	- 0.50** (119)	- 0.47** (75)	- 0.44** (69)
9B	- 0.51** (262)	- 0.56** (120)	- 0.43** (142)	- 0.50** (118)	- 0.53** (75)	-0.39** (69)
10A	- 0.39** (249)	- 0.37** (109)	- 0.43** (140)	-0.35** (123)	- 0.36** (60)	- 0.32* (66)
10B	- 0.39** (161)	- 0.55** (84)	- 0.17 (77)	- 0.38 (23)	- 0.57** (74)	- 0.16 (64)

* $0.001 \leq p < 0.01$, ** $p < 0.001$

For the correlations used in the Cross-Lagged Panel analysis of the results of the five-year longitudinal study, only the results of the 66 students who participated in the entire programme were used.

In **Table 20** are listed the correlations between achievement and anxiety for each semester throughout the longitudinal study.

In the case of the entire group of students participating in the programme the correlations between the concurrent achievement tests and the anxiety scales were moderate to strong, significant and in the negative direction for each of the periods from year 6 through to year 10.
Similarly the results of the male students were also moderate to strong, in a negative direction and at a significant level.

Inspection of the female student results showed all correlations to be strong, significant and negative with the exception of those of year 8, first semester, when the correlation was – 0.21 and at the end of year 10, second semester, with a correlation of – 0.17.

The result at year 8, semester one, can be explained in part, by an inspection of the correlations obtained by the different schools at that time. School A's result of – 0.12 is weak and not at a significant level. Hence, as school A is coeducational, this result with respect to the female students would have an influence on the overall result for the entire female group of students. Similarly, at year 10, semester two, school C's result is also weak and insignificant, (- 0.16). School C is an all girls school, hence this weak correlation would affect the overall result of the female group of students too.

Why school A and school C should have recorded very weak and insignificant correlations at year 8, semester one, and year 10, semester two respectively has been very difficult to explain satisfactorily; the following possible reasons have been hypothesised, but there are strong arguments against each of them. School A starts at year 6 with the middle school going to year 9. The transition from primary mode to secondary mode is more gradual.

However, at year 8, semester one, all schools are teaching a similar syllabus, using similar textbooks and using subject specific teachers. Hence, the fact that school A's students commence their studies in the secondary school earlier than the other two schools should have no influence on their year 8 results. But all three schools have years 6 – 10!

At year 10, semester two, school C's correlation result was very different from all other results. This school is a single sex girls school. One suggestion put forward to explain the discrepancy was that at this school the year 11 study programme for each of the students would have been determined during the third term, (early in the second semester) before the students participated in the final test of this study. As their programme had been established they may have decided to relax their efforts and treat the questions in the mathematics test and the anxiety questionnaire with less than full attention. However, all schools would have carried out a similar programming timetable and that particular line of reasoning is not applicable.

Another possible explanation for the discrepancy of correlations at year 8, semester one, could be that at that period in the semester no tests had been administered to the students at school A. Also there may have been little stress being experienced by the students with respect to classroom work and work set for homework. Hence, the students were operating at a low level of arousal. However, it is not likely that at school A alone the situation arose that no formal testing of the student had taken place.

Yet another possibility for the weak correlation at year 8, semester one, could have been the change in the composition of the class. At year 7, semester two, the year numbers in schools A, B and C were 86, 49 and 52 students respectively. At year 8, semester one, the number of students increased to 145, 72 and 72 respectively. These new year levels represent a 68%, 47% and a 38% increase respectively. With new students entering a year level the make up of that year level would change. New students would need to make new friendships, and new personalities would need to be contended with. As a result, the person needs of each student will take precedence over the higher needs of knowledge, understanding, aesthetic concerns and self-actualization. That is, the needs of security, belonging and esteem will need to be fulfilled first, (Maslow, 1968). However, although school A has the greatest increase in class numbers, the remaining two schools also have greatly increased numbers. Hence, this hypothesis does not hold in this instance.

From the second half of year 8 until the end of the first semester year 10 the relationship between achievement and anxiety was strong, illustrating a continuous interplay between achievement levels and anxiety levels. That is, any increase in achievement may be accounted for by the decline in anxiety, or an increase in anxiety may bring about a decrease in a student's level of achievement, the degree of this relationship ranging from 11% to 31%.

These results confirm that anxiety in mathematics is present throughout years 6 to 10 and that the level of anxiety is related to the level of achievement of the students.

The correlation between anxiety and achievement was in a negative direction throughout the period of the study. The results reaffirming the earlier research findings of Wine (1980); Fennema, Sherman, Richardson and Webb (1972) who in general conducted their research with older students. Higher achievement is associated with lower anxiety, and lower achievement with higher anxiety. Causation determination is not possible.

Throughout the length of the study the correlations between mathematics anxiety and mathematics achievement are strong and negative and at a significant level, ($p \leq 0.001$). One reason put forward is that a satisfactory level of achievement is necessary if the students are to progress to the next level of knowledge in the field of mathematics.

High achievers will experience less anxiety but low achievers will experience a higher level of anxiety.

According to Yerkes and Dodson,(1908) if arousal is at a low level with respect to an easy task, then an increase in the level of arousal is necessary before optimum performance is obtained. On the other hand, if the task is difficult, a certain level of arousal is also necessary in order that the performer operates at optimum level. In the cases where the level of arousal is low and maximum performance is not attained, then the relationship between arousal and performance is positive. At levels of arousal greater than that necessary to attain an optimum performance level any further increase in arousal brings about a decrease in the performance level. Thus, at this stage, the relationship between arousal and performance is negative.

The scatter diagrams of the outcomes for each semester's achievement ~ anxiety test are shown in **Appendix B**.

Examination of the scatter diagrams ascertained that maximum achievement occurred when anxiety was at or near zero level. In other words, the students were at their optimum arousal levels during their participation in the achievement tests as in no case was achievement greatest when anxiety levels were high on the anxiety scale. Thus it can be said that the Yerkes ~ Dodson Law does not hold with respect to mathematics performance and mathematical anxiety. The greater the level of arousal, the lower is the level of performance. However, not only was maximum achievement related to very low anxiety, but also low levels of achievement were recorded with low levels of anxiety in a number of instances.

Each of the semester diagrams of the plots of achievement and anxiety show that those students who attained maximum achievement were experiencing low levels of anxiety

Each scattergram contained a '*line of best fit*', and all of these lines have a negative slope illustrating that an increase in achievement is associated with a decrease in anxiety and vice versa. The scattergram also showed that for lower levels of anxiety a range of levels of achievement was possible. From all scattergrams it can be seen that students' achievement scores ranged from very low to very high. With lower levels of anxiety, (less than 20%) not only was the maximum in achievement attained, but all levels from very low to maximum were also attained. In all scattergrams a high level of anxiety resulted in a low level of achievement.

Conclusion

The correlations between achievement and anxiety were all in the negative direction for the total sample, the male sample, the female sample and for each of the three participating schools throughout the period of this longitudinal study. The great majority of the relationships were strong, as were their levels of significance.

Thus it can be said that the students were concerned about their results in mathematics to such an extent that a change in achievement brought about an opposite change in the level of anxiety, or a change in anxiety was manifested by an opposite change in achievement. However the predominance of achievement over anxiety or the predominance of anxiety over achievement is not possible to determine from these correlations. The possibility of causation is discussed in chapter 7.

The correlations were at a significant level during each stage of the academic progress of the students ($r > 0.3$) and there was a negative relationship between the mathematics achievement test and the mathematics anxiety scale. The results showed that, as a student's level of mathematics achievement increased, there was a corresponding decrease in the level of mathematics anxiety experienced. Similarly, as a student's level of mathematics anxiety increased there was a decline in the level of achievement.

There was a distortion of the correlation at year 8, semester 1 in School A, and this resulted in distortions for the male, female and overall correlations at that time.

Chapter 7

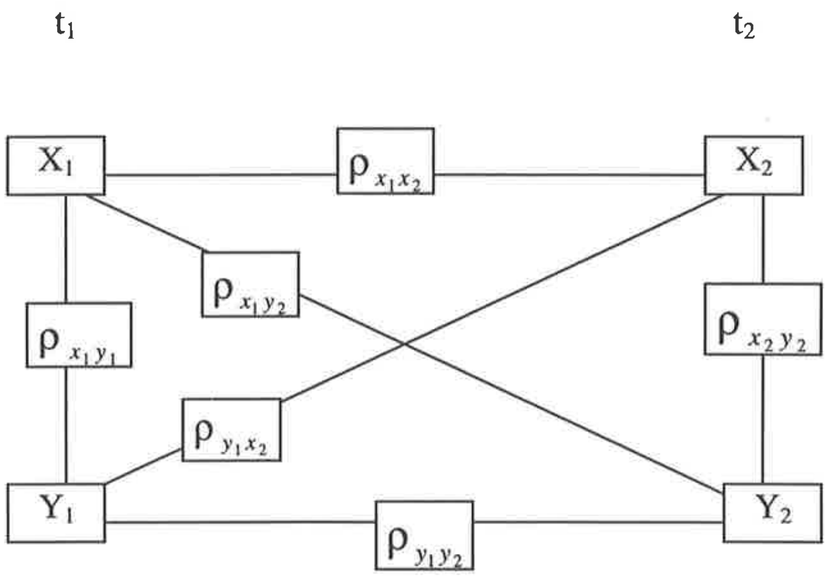
LONGITUDINAL PANEL CORRELATIONS

The technique of longitudinal panel correlations was introduced into the field of the social sciences by Campbell (1963), Campbell and Stanley (1963) and Peltz and Andrews (1964).

The technique requires two variables X and Y measured over two different points in time, t_1 and t_2. These two variables and the two times generate four variables - X_1, X_2, Y_1 and Y_2 which in turn generate six correlations, two of which are test-retest or auto-correlations, $\rho_{x_1x_2}$ and $\rho_{y_1y_2}$, two of which are current or synchronous correlations, $\rho_{x_1y_1}$ and $\rho_{x_2y_2}$ and the third pair are cross-lagged or predictive correlations, $\rho_{x_1y_2}$ and $\rho_{x_2y_1}$. These correlations are illustrated in the **Figure 3**.

Figure 3

Cross-lagged Correlation Model



Lawler (1968) states that " *The Cross-Lagged Correlation method involves gathering similar data on the two variables that are to be tested for causality at two different points in time.*" (p.463).

The logic underlying this type of analysis rests upon the time lag that typically exists when one variable causes another. The argument is that if X causes Y then the present state of X (X_1) should be more strongly related to Y's future state (Y_2) than to Y's past or present state (Y_0 or Y_1). Thus, where X causes Y, then, $\rho_{x_1y_2}$ where Y is measured after X, should be greater than each of $\rho_{x_1 y_0}$ and $\rho_{x_1 y_1}$ where Y is measured either before, or at the same time, as X. Thus, by comparing $\rho_{x_1 y_2}$ with the relative sizes of, $\rho_{x_1 y_1}$, $\rho_{x_1 y_2}$, and $\rho_{x_1 y_0}$ where Y is measured at the same time as, after, or before X, it is possible to determine whether the hypotheses that X causes Y or that Y causes X are more tenable.

The determination of the preponderance of causation was hampered by lack of proper methodological tools with which to examine the issue, the principal drawback being that the question of preponderance is not simply about correlations, as correlation does not imply causation. Hence, assuming that the two variables could be independently measured, the ideal study would examine the relationship between these two factors and the changes of their relationship over time.

With the development of the cross-lagged panel technique, inferring causal results has become possible. This method is based on one of science's most useful rules of causal inference, that of time precedence. In every science, when a given event consistently precedes the occurrence of another, and the reverse does not hold, only one of two possibilities can be entertained.

- ◊ *Event 1 is presumed to be a cause of Event 2, (note that it could be possibly only one of many), or*
- ◊ *Both Event 1 and Event 2 are the effects of some more general cause or causes.*

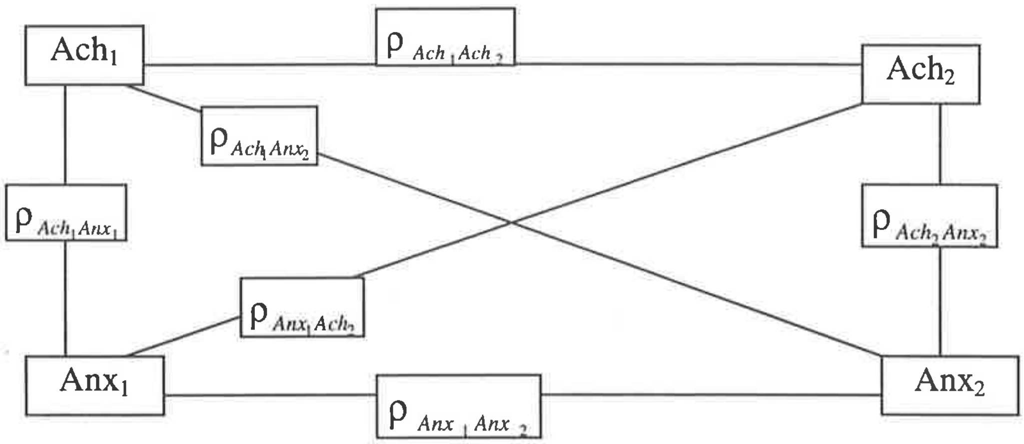
By controlling the application of the independent variable X, the experimenter is assured that its occurrence does not depend upon some more general prior event, and thus any differences occurring between experimental and control subjects can be attributed to the presence or absence of the independent variable. In this way, the second alternative that Events 1 and 2 are both effects of some more general cause(s) is rendered implausible. (Crano and Brewer ,1973).

Correlation techniques can be employed to study the strength of a relationship between variables. However, no reliable causal estimate can be made from a single coefficient of correlation taken independently. When there is correlation information relating to two variables at more than one point in time, then the concept of causality can be examined.

In the present study, students' performance scores in mathematics and students' rating scores in mathematics anxiety were both available at a number of time points. The pattern of possible correlations takes the form as presented in **Figure 4.**

Figure 4.

Showing the Auto-Correlations, the Synchronous Correlations and the Cross-lagged Correlations between Achievement and Anxiety



Let us also suppose for the sake of later exposition that the students' mathematics anxiety ratings measured at time one were followed at time two by a consistent pattern of the students' mathematics achievement scores, such that a high status on anxiety was always followed by a low status in achievement. Suppose further, that the opposite relationship did not hold that is that status on achievement at time one held no implication for anxiety at time two. In such a situation the cross lagged correlation $\rho_{Anx_1Ach_2}$ would exceed $\rho_{Ach_1Anx_2}$, and such discontinuity, in the absence of the operation of an unspecified third (causal) variable, would suggest that mathematics anxiety served as a cause (though possibly only one of many) of the students' lack of later achievement.

Rogosa's Structural Regression Model

The attribution of causal predominance in cross-lagged panel analysis is based on the difference between the cross-lagged correlations $\rho_{x_1y_2} - \rho_{x_2y_1}$. If the data indicate that $\rho_{x_1y_2} - \rho_{x_2y_1}$ is positive, then X causes Y. If the data indicate that $\rho_{x_1y_2} - \rho_{x_2y_1}$ is negative the predominant causation is said to be in the direction of Y causes X. According to Rogosa (1980), cross-lagged correlation discards much information. A statistically significant difference between the sample cross-lagged correlations is given the same interpretation regardless of the magnitude of the difference and regardless of the individual correlations. Also, no distinction is made between large and equal cross-lagged correlations and small and equal cross-lagged correlations.

Rogosa cites Kenny's (1973, 1975) formulation of the assumptions of cross-lagged correlations with respect to *spuriousness* - the absence of direct causal influences between X and Y. Another major assumption of the cross-lagged correlation technique is *stationarity*, that is, the causal structures for X and Y do not change over time. When the synchronous correlations, $\rho_{x_1 y_1}$ and $\rho_{x_2 y_2}$, are equal, stationarity is assumed, but equality of the synchronous correlations is a necessity but not a sufficient condition for stationarity. The cross-lagged correlations may be unequal when the synchronous correlations are equal and the representation of spuriousness is valid.

Rogosa's second key assumption with respect to cross-lagged correlations is synchronicity: that is the measures at each time period are obtained at the same time. This assumption is implicit in our description of the longitudinal panel data.

Rogosa continues '*Kenny (1975), introduced an assumption termed* ***homogeneous stability*** *that is evoked to help distinguish between the alternative hypotheses that X causes an increase in Y and that Y causes an increase in X, once the null hypothesis of spuriousness has been rejected. The assumption is not stated explicitly in terms of* *parameters, but Kenny did state that equal stabilities for X and Y are consistent with this assumption. In recent applications of cross-lagged correlations (Calsyn and Kenny, 1977; Crano, 1977; Crano and Mellon, 1978; Humphreys and Stubbs, 1977) this assumption has not been used or discussed,' (Rogosa, p250).*

The model can be presented by the structural regression equations:

$$X_2 = \beta_0 + \beta_1 X_1 + \gamma_2 Y_1$$

$$Y_2 = \gamma_0 + \beta_2 X_1 + \gamma_1 Y_1 \quad \text{.........................(1)}$$

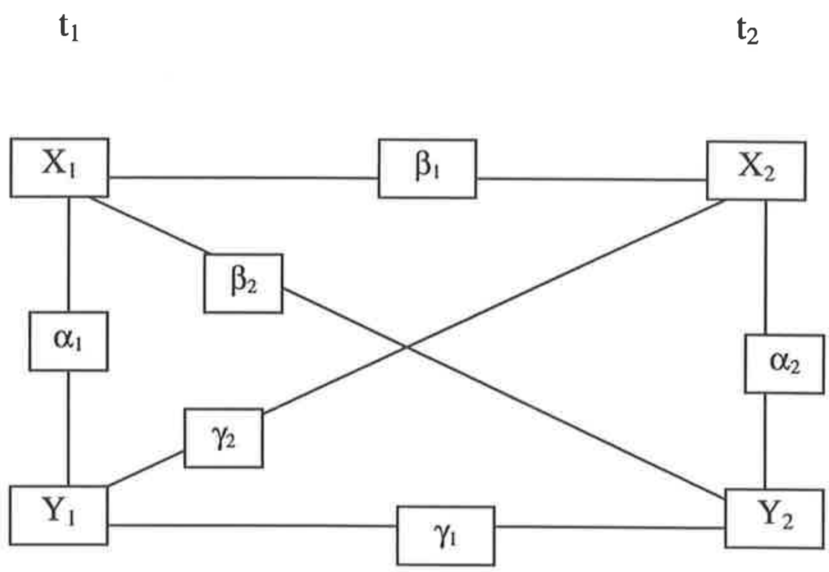
Restrictions on the nature of the causal influences between X and Y are built into **Equation 1,** and **Figure 5** the most important being the assumption that all causal influences are lagged. Simultaneous causal influences between X_2 and Y_2 are not included. Also, assumptions of linearity and additivity of causal influences are built into the model.

Figure 5 represents a specific structural regression model for data gathered for two variables over two periods of time. (2W2V).

The two variables under consideration are X and Y. X_1 and Y_1 represent the variables at time period 1 - the initial values of X and Y. X_2 and Y_2 represent the values of the variables at a later time period.

Figure 5.

Rogosa's Structural Model



The parameters β_1 and γ_1 represent the influence of a variable on itself over time. The parameters β_2 and γ_2 represent the lagged reciprocal causal effects between X and Y. Thus β_2 and γ_2 are the most important quantities in the investigation of reciprocal causal effects in 2W2V panels.

Where there is no causal effect between variables the relevant model parameters will be zero. With respect to **Equation 1**, the absence of any direct causal effects between X and Y is represented by $\beta_2 = \gamma_2 = 0$. Also, a causal predominance of X over Y would be represented by a zero (or a negligible) value of γ_2 and a non-negligible value of β_2. Similarly, a non-negligible value of γ_2 and a zero, or negligible value of β_2 would represent a causal predominance of Y over X.

Using the model, the difference between the cross-lagged correlations can be expressed as standardized versions of the structural parameters. Rogosa (1980, page 251) presented the equations as follows:

$$\rho_{x_1 y_2} - \rho_{x_2 y_1} = (1 - \rho^2_{x_1 y_1})(\beta^*_2 - \gamma^*_2) + \rho_{x_1 y_1}(\rho_{y_1 y_2} - \rho_{x_1 x_2}).$$

This can be rearranged to find $\beta^*_2 - \gamma^*_2$

$$\beta^*_2 - \gamma^*_2 = [\rho_{x_1 y_2} - \rho_{x_2 y_1} - \rho_{x_1 y_1}(\rho_{y_1 y_2} - \rho_{x_1 x_2}).]/(1 - \rho^2_{x_1 y_1})$$

where β^*_2 and γ^*_2 are the standardized structural parameters.

He used the expressions to demonstrate that the difference between the cross-lagged correlations does not provide a sound basis for spuriousness or causal dominance, even when the assumptions of cross-lagged correlations are satisfied. Equal cross-lagged correlations do not necessarily support a conclusion of the absence of direct causal effects, and unequal cross-lagged correlations do not necessarily support a conclusion of causal dominance.

Equal Cross-Lagged Correlations

In cross-lagged correlations *equal cross-lagged correlations* indicate a conclusion of a spurious (or nonexistent) pattern of causal influence between X and Y. This conclusion is unsound because equal cross-lagged correlations are consistent with many patterns of direct causal influence.

As can be seen from equation (1) if β_2^* and γ_2^* are large and equal, and if the stabilities of X and Y are equal, the cross-lagged correlations are equal. Equal cross-lagged correlations are also consistent with unequal causal effects, the difference between the stabilities offsetting the difference between β_2^* and γ_2^*. Equal cross-lagged correlations are consistent with the absence of causal effects - $\beta_2^* = \gamma_2^* = 0$ – only when the stabilities of X and Y are equal.

All of the difficulties with the interpretation of equal cross-lagged correlations persist when causal effects are defined in terms of unstandardized structural parameters. Because the difference between the cross-lagged correlations increases as $\sigma_{x_1} \sigma_{x_2} / \sigma_{y_1}, \sigma_{y_2}$ increases (all other parameters constant), changes to variances over time make equal cross-lagged correlations consistent with an ever widening variety of configurations of unstandardized causal parameters than were indicated previously for standardized parameters.

The evidence used in cross-lagged correlations to reach a determination of spuriousness is equal cross-lagged correlations and equal synchronous correlations to satisfy stability. However, as this evidence is consistent with many patterns of direct causal influence, the determination of spuriousness in cross-lagged correlations is unsound.

Unequal Cross-Lagged Correlations

Unequal *cross-lagged correlations* indicate a causal predominance in cross-lagged correlations. The shortcomings of cross-lagged correlations are seen in **Equations 1** and **2**. A causal predominance will be indicated by cross-lagged correlations when $\beta_2^* - \gamma_2^* \neq 0$ and the stabilities are unequal. Causal predominance is attributed to the variable with the lower stability, because $\rho_{x_1 y_2} - \rho_{x_2 y_1} = \rho_{x_1 y_1}(\rho_{y_1 y_2} - \rho_{x_1 x_2})$.

In addition to indicating a causal predominance when there is none, cross-lagged correlations may indicate a causal predominance opposite to that indicated by the structural parameters. Whenever $\rho_{y_1 y_2} - \rho_{x_1 x_2}$ and $\beta_2^* - \gamma_2^*$ differ in sign, the direction of causal predominance indicated by the cross-lagged correlation is antipodal to that determined by the structural parameters.

Because of Rogosa'a demonstration that cross-lagged correlations can be misleading, The author chose instead to use his standardised structural parameters β_2^* and γ_2^* and in particular, their difference $\beta_2^* - \gamma_2^*$ as the appropriate determinant of causality.

With respect to the current longitudinal study, the variables under consideration are each student's level of anxiety, Y, and his or her level of achievement, X.

The correlation between achievement and anxiety were all found to be negative throughout the longitudinal study. Hence, we would expect a lowering of achievement to coincide with an increase of anxiety and an increase in achievement if the level of anxiety declined.

We would consequently expect the standardized structural parameters β_2^* and γ_2^* to be negative. If β_2^* - γ_2^* is negative, it is because β_2^* dominates and if β_2^* dominates we can say that an increase or decrease in achievement causes a decrease or an increase in anxiety respectively. Similarly, if β_2^* - γ_2^* is positive, then γ_2^* dominates, and we can conclude that changes in anxiety will cause changes in achievement.

According to Byrne (1984) in studies that address the direction of causality question, the following prerequisites must be followed:

◊ *A statistical relation must be established.*

◊ *Longitudinal designs should be used with a clearly defined time precedence.*

◊ *The causal model must be tested.*

The first of these prerequisites was met as, in the first part of this study, the presence of anxiety throughout the five year period was established and there was a moderate to strong relationship between anxiety and achievement at each semester throughout the period. The second prerequisite was also met as each panel of the cross lagged panel analysis was separated from the previous correlation determination by a period of six months. [The tests were carried out towards the end of each semester]. Also each achievement test and the corresponding anxiety scale were administered on the same day.

The third prerequisite – that the causal model be tested – was adhered to using Rogosa's **Structural Regression Model**, and the difference $\beta_2^* - \gamma_2^*$ of the standardised structural parameters which are the basis of the model.

Chapter 8.

Results of the Longitudinal Correlations using Rogosa's Structural Regression Model.

The cross-lagged correlations, using the Spearman rank correlations, were established for the total sample, the male sample and the female sample of students. These results are shown in **Tables 21, 22** and **23**.

The auto correlations for the anxiety scales and the achievement tests results were determined for each of the nine test periods. The auto correlations for the anxiety scales of the total sample of students, the male sample and the female sample are found in **Tables 24, 25** and **26** respectively. The auto correlations for the achievement tests for the same three groups are displayed in **Tables 27, 28** and **29** respectively.

The **Beta – Gamma** differences of Rogosa's model are shown in **Table 30** for the total sample of students, and in **Tables 31** and **32** for the male and female samples respectively.

Table 33 lists the binomial distribution of the results of achievement and anxiety occurring by chance.

Table 21

The Achievement-Anxiety Spearman Cross Lagged Correlations for the Total Sample ($\rho_{x_1 y_2}$, $\rho_{x_2 y_1}$ and $\rho_{x_1 y_1}$)

	Ach 1	Ach 2	Ach 3	Ach 4	Ach 5	Ach 6	Ach 7	Ach 8	Ach 9
Anx 1	-0.24	-0.29	-0.24	-0.22	-0.10	-0.17	-0.18	-0.28	-0.24
Anx 2	-0.33	-0.41	-0.32	-0.31	-0.21	-0.26	-0.24	-0.39	-0.32
Anx 3	-0.50	-0.57	-0.43	**-0.49**	-0.28	-0.26	-0.33	**-0.41**	-0.20
Anx 4	-0.36	-0.46	**-0.38**	-0.43	-0.13	-0.25	-0.36	**-0.51**	-0.25
Anx 5	-0.38	-0.49	-0.45	-0.46	-0.23	**-0.33**	**-0.35**	**-0.40**	-0.26
Anx 6	-0.38	-0.45	-0.47	-0.39	**-0.12**	-0.23	-0.35	-0.33	-0.18
Anx 7	-0.38	-0.49	-0.34	-0.37	**-0.33**	-0.41	-0.47	-0.42	-0.39
Anx 8	-0.37	-0.45	**-0.30**	**-0.30**	**-0.31**	-0.37	-0.47	-0.39	-0.36
Anx 9	-0.41	-0.47	-0.32	-0.32	-0.31	-0.48	-0.54	-0.39	-0.40

The figures in bold print indicate that the correlation Anx_1Ach_2 was greater than Ach_1Anx_2.

Table 22.

The Achievement – Anxiety Spearman Cross Lagged Correlations

for the Male Sample ($\rho_{x_1y_2}$, $\rho_{x_2y_1}$ and $\rho_{x_1y_1}$)

	Ach 1	Ach 2	Ach 3	Ach 4	Ach 5	Ach 6	Ach 7	Ach 8	Ach 9
Anx 1	-0.12	**-0.18**	-0.16	-0.10	-0.03	-0.02	-0.04	-0.26	-0.15
Anx 2	**-0.16**	-0.28	-0.20	-0.17	-0.10	-0.12	-0.21	**-0.43**	-0.29
Anx 3	-0.35	-0.41	-0.35	**-0.42**	-0.30	-0.24	-0.21	**-0.38**	-0.28
Anx 4	-0.14	-0.38	**-0.20**	-0.23	-0.08	-0.17	-0.23	**-0.50**	-0.31
Anx 5	-0.37	-0.54	-0.37	-0.54	-0.26	**-0.34**	-0.27	**-0.37**	-0.24
Anx 6	-0.49	-0.51	-0.42	-0.37	**-0.24**	-0.34	-0.29	-0.29	-0.29
Anx 7	-0.42	-0.51	-0.28	-0.41	-0.33	.-44	-0.45	**-0.43**	-0.37
Anx 8	-0.28	**-0.41**	**-0.20**	**-0.22**	**-0.19**	-0.33	**-0.40**	-0.43	-0.26
Anx 9	-0.24	-0.59	-0.36	-0.37	-0.36	-0.64	-0.63	-0.42	-0.40

The figures in bold print indicate that the correlation between Anx_1Ach_2 was greater than Ach_1Anx_2.

Table 23.

Achievement – Anxiety Spearman Cross Lagged Correlations for the Female Sample ($\rho_{x_1 y_2}$, $\rho_{x_2 y_1}$ and $\rho_{x_1 y_1}$)

	Ach 1	Ach 2	Ach 3	Ach 4	Ach 5	Ach 6	Ach 7	Ach 8	Ach 9
Anx 1	-0.41	-0.44	-0.38	-0.37	-0.17	-0.29	-0.36	-0.32	**-0.41**
Anx 2	-0.54	-0.61	-0.52	-0.45	-0.32	**-0.44**	-0.39	-0.4	**-0.45**
Anx 3	-0.67	-0.72	-0.48	-0.57	-0.24	-0.27	**-0.46**	-0.42	**-0.11**
Anx 4	-0.58	-0.5	-0.57	-0.62	-0.15	-0.28	**-0.51**	**-0.55**	-0.27
Anx 5	-0.43	-0.46	-0.5	-0.42	-0.2	**-0.29**	**-0.38**	-0.39	-0.25
Anx 6	-0.31	**-0.37**	-0.48	-0.41	**-0.01**	-0.11	-0.33	-0.31	-0.08
Anx 7	-0.38	-0.48	**-0.32**	**-0.36**	**-0.37**	-0.42	-0.46	-0.39	**-0.47**
Anx 8	-0.42	-0.46	-0.39	**-0.37**	-0.39	-0.39	-0.53	-0.33	**-0.51**
Anx 9	**-0.29**	**-0.3**	**-0.19**	-0.27	-0.31	-0.31	**-0.31**	**-0.31**	-0.42

The figures in bold print indicate that the correlation between Anx_1Ach_2 was greater than Ach_1Anx_2.

To determine a causal effect of achievement on anxiety for the longitudinal panel data collected over nine time periods, as the subjects progressed from year 6 in the preparatory school to the end of year 10 in the secondary school, the **Structural Regression Model** developed by Rogosa (1980) was utilized. The use of the Structural Regression Model necessitated the determination and use of the auto test correlations for the anxiety scales and the achievement tests. The anxiety scale auto correlations are shown in **Tables 24, 25** and **26**.

Table 24

The Anxiety Auto Correlations of the Total Sample ($\rho_{y_1 y_2}$)

	Anx 1	Anx 2	Anx 3	Anx 4	Anx 5	Anx 6	Anx 7	Anx 8	Anx 9
Anx 1	1								
Anx 2	0.77	1							
Anx 3	0.52	0.65	1						
Anx 4	0.64	0.67	0.77	1					
Anx 5	0.45	0.45	0.63	0.75	1				
Anx 6	0.42	0.41	0.55	0.63	0.76	1			
Anx 7	0.43	0.44	0.51	0.49	0.61	0.58	1		
Anx 8	0.49	0.45	0.47	0.54	0.55	0.52	0.86	1	
Anx 9	0.21	0.2	0.25	0.27	0.34	0.4	0.69	0.69	1

The auto test correlations of the total sample with respect to the nine anxiety scale results are shown in **table 24** above. Thirty-two of the thirty-six correlations are greater than 0.3 indicating at least a moderate relationship between each of the scales. These correlations will be used in the Rogosa Structural Regression formula.

Table 25

The Anxiety Auto Correlations for the Male Sample

$(\rho_{y_1 y_2})$

	Anx 1	Anx 2	Anx 3	Anx 4	Anx 5	Anx 6	Anx 7	Anx 8	Anx 9
Anx 1	1								
Anx 2	0.8	1							
Anx 3	0.61	0.74	1						
Anx 4	0.71	0.78	0.8	1					
Anx 5	0.44	0.46	0.65	0.64	1				
Anx 6	0.39	0.52	0.52	0.46	0.63	1			
Anx 7	0.34	0.5	0.58	0.54	0.45	0.51	1		
Anx 8	0.49	0.52	0.5	0.6	0.32	0.39	0.8	1	
Anx 9	0.14	0.18	0.25	0.27	0.23	0.43	0.74	0.76	1

As with the test retest correlations of the anxiety scales for the total sample of students, the majority of the correlations for the male sample are at moderate to strong levels, only 5 being less that 0.3. The highest degree of correlations was 0.8 indicating that 64% of the content of one scale is associated with the content of another scale, but no two scales are identical.

Table 26.

The Anxiety Auto Correlations for the Female Sample

$(\rho_{y_1 y_2})$

	Anx 1	Anx 2	Anx 3	Anx 4	Anx 5	Anx 6	Anx 7	Anx 8	Anx 9
Anx 1	1								
Anx 2	0.7	1							
Anx 3	0.51	0.62	1						
Anx 4	0.59	0.62	0.7	1					
Anx 5	0.53	0.53	0.57	0.81	1				
Anx 6	0.48	0.37	0.5	0.74	0.84	1			
Anx 7	0.58	0.5	0.43	0.47	0.67	0.58	1		
Anx 8	0.55	0.45	0.37	0.48	0.67	0.61	0.87	1	
Anx 9	0.34	0.31	0.25	0.28	0.37	0.37	0.63	0.61	1

Table 26 contains the auto test correlations of the female sample of students. The correlations are moderate to strong throughout the nine testing periods.

The test-retest correlations for the results of the nine different achievement tests are shown in **tables 27, 28 and 29.** The results range from a low of 0.3 (Ach_9Ach_2, female sample) to a high of 0.89 (Ach_6Ach_2, male sample.) This indicates that there were items in common between two tests at any period of time but none of the tests were identical.

Table 27

The Achievement Auto Correlations of the Total Sample

$(\rho_{x_1 x_2})$

	Ach 1	Ach 2	Ach 3	Ach 4	Ach 5	Ach 6	Ach 7	Ach 8	Ach 9
Ach 1	1								
Ach 2	0.77	1							
Ach 3	0.76	0.75	1						
Ach 4	0.76	0.67	0.79	1					
Ach 5	0.72	0.65	0.67	0.71	1				
Ach 6	0.73	0.71	0.78	0.75	0.76	1			
Ach 7	0.64	0.65	0.65	0.6	0.5	0.72	1		
Ach 8	0.58	0.58	0.64	0.63	0.52	0.66	0.72	1	
Ach 9	0.47	0.57	0.66	0.57	0.59	0.71	0.66	0.59	1

Table 28.

The Achievement Auto Correlations for the Male Sample

$(\rho_{x_1 x_2})$

	Ach 1	Ach 2	Ach 3	Ach 4	Ach 5	Ach 6	Ach 7	Ach 8	Ach 9
Ach 1	1								
Ach 2	0.81	1							
Ach 3	0.84	0.86	1						
Ach 4	0.81	0.76	0.83	1					
Ach 5	0.77	0.8	0.79	0.8	1				
Ach 6	0.81	0.89	0.83	0.77	0.82	1			
Ach 7	0.61	0.7	0.58	0.56	0.57	0.77	1		
Ach 8	0.55	0.71	0.61	0.6	0.64	0.66	0.67	1	
Ach 9	0.5	0.71	0.68	0.59	0.65	0.79	0.68	0.64	1

Table 29

The Achievement Auto Correlations for the Female Sample

$(\rho_{x_1 x_2})$

	Ach 1	Ach 2	Ach 3	Ach 4	Ach 5	Ach 6	Ach 7	Ach 8	Ach 9
Ach 1	1								
Ach 2	0.69	1							
Ach 3	0.58	0.52	1						
Ach 4	0.69	0.54	0.73	1					
Ach 5	0.54	0.35	0.32	0.55	1				
Ach 6	0.57	0.41	0.63	0.67	0.63	1			
Ach 7	0.66	0.46	0.67	0.63	0.34	0.58	1		
Ach 8	0.61	0.37	0.68	0.68	0.35	0.66	0.76	1	
Ach 9	0.37	0.3	0.52	0.5	0.44	0.55	0.61	0.52	1

As can be seen from an inspection of **Tables 27, 28** and **29** the correlations between any two of the achievement tests is moderate to strong. Each was testing an area of mathematics but no two were testing identical areas.

The Beta – Gamma Differences.

As the study was longitudinal in nature all outcomes of the correlations between the variables were required. The achievement-anxiety Spearman correlations totalled eighty-one outcomes, the 9 anxiety scales correlated with each of the 9 achievement tests throughout the period of the study. The Rogosa's Beta-Gamma Differences between achievement and anxiety for the total sample throughout the study are shown in **Table 30** the male sample results are shown in **Table 31** and **Table 32** depicts the results of the female sample. With further reference to **Tables 30, 31** and **32** only the differences below the main diagonal were considered in the study, because those above the diagonal correspond to the causation of events at time 1 by events at time 2.

The formula for the Beta – Gamma Difference is

$$\beta_2^* - \gamma_2^* = [\rho_{x_1y_2} - \rho_{x_2y_1} - \rho_{x_1y_1}(\rho_{y_1y_2} - \rho_{x_1x_2}).]/(1 - \rho^2_{x_1y_1})$$

Note that it is not symmetrical in t_1 and t_2 – exchanging the two would involve looking at the hypothesis that the later events caused the earlier ones. Consequently only the values below the leading diagonal are considered in each table.

Table 30

Beta - Gamma Differences between Achievement and Anxiety of the Total Sample

Period	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8
2	-0.04							
3	-0.34	-0.35						
4	-0.18	-0.18	**0.12**					
5	-0.37	-0.44	-0.23	-0.38				
6	-0.30	-0.38	-0.38	-0.24	**0.22**			
7	-0.27	-0.40	-0.09	-0.07	**0.05**	-0.10		
8	-0.12	-0.14	**0.05**	**0.21**	**0.10**	-0.08	**0.02**	
9	-0.25	-0.36	-0.36	-0.24	-0.11	-0.39	-0.17	**0.01**

The figures in bold print indicate that the Beta - Gamma difference is positive, i.e. the Gamma value is greater than the Beta value.

Table 31

Beta–Gamma Differences for the Male Sample

Period	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8
2	**0.02**							
3	- 0.22	- 0.26						
4	**0.23**	-0.60	**0.24**					
5	-0.39	-0.58	-0.14	-0.52				
6	-0.53	-0.54	-0.33	-0.29	**0.05**			
7	-0.42	-0.39	-0.08	-0.19	-0.10	-0.27		
8	-0.03	-0.04	**0.16**	**0.30**	**0.10**	-0.15	**0.11**	
9	- 0.14	- 0.49	- 0.26	- 0.14	- 0.25	-0.53	- 0.29	- 0.13

The figures in bold print indicate that the Beta - Gamma difference is positive, i.e. the Gamma value is greater than the Beta value.

Table 32

Beta–Gamma Differences for the Female Sample

Period	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8
2	-0.12							
3	-0.38	-0.19						
4	- 0.30	-0.02	-0.01					
5	- 0.32	-0.08	-0.19	-0.20				
6	- 0.07	**0.06**	-0.32	-0.12	**0.44**			
7	-0.06	-0.09	**0.05**	**0.10**	**0.17**	-0.11		
8	- 0.15	- 0.03	- 0.12	**0.12**	**0.16**	-0.12	- 0.11	
9	**0.13**	**0.19**	- 0.23	- 0.10	- 0.03	- 0.37	**0.20**	**0.26**

The figures in bold print indicate that the Beta - Gamma difference is positive, i.e. the Gamma value is greater than the Beta value.

In this longitudinal study using Rogosa's Structural Regression Model β_2 is the linear coefficient of achievement at time period 1 related to anxiety at time period 2, and γ_2 is the linear coefficient of anxiety at time period 1 related to achievement at time period 2. As all correlations were negative, we would expect both of these coefficients to be negative.

The results of **Table 30** show that out of the total of 36 outcomes, 28 were such that $\beta_2^* - \gamma_2^*$ was negative, indicating that β_2 was dominant. These results are **<u>not</u>** highlighted. Thus in 28 of the 36 outcomes, the results supported the hypothesis that a change in achievement caused an opposite change in anxiety. In other words, if the level of student achievement increases, the level of student anxiety decreases and if achievement declines an increase in the level of anxiety results.

The probability of obtaining at most 8 of the 36 outcomes contrary to the hypothesis by chance alone is 0.0006.

Table 33

Binomial Distributions of the Results of Achievement and Anxiety Occurring by Chance.

Significance of at most n occurrences out of 36

n	n selections from 36	$(1/2)^{36}$	significance	cumulative significance
0	1	1.4552E-11	1.4552E-11	
1	36	1.4552E-11	5.2387E-10	5.38421E-10
2	630	1.4552E-11	9.1677E-09	9.70613E-09
3	7140	1.4552E-11	1.039E-07	1.13607E-07
4	58905	1.4552E-11	8.5718E-07	9.70787E-07
5	376992	1.4552E-11	5.486E-06	6.45674E-06
6	1947792	1.4552E-11	2.8344E-05	3.48008E-05
7	8347680	1.4552E-11	0.00012147	0.000156276
8	30260340	1.4552E-11	0.00044035	**0.000596621**
9	94143280	1.4552E-11	0.00136997	0.001966587
10	254186856	1.4552E-11	0.00369891	0.005665492
11	600805296	1.4552E-11	0.00874287	**0.01440836**
12	1251677700	1.4552E-11	0.01821431	0.032622668
13	2310789600	1.4552E-11	0.03362641	0.066249082
14	3796297200	1.4552E-11	0.0552434	0.121492477
15	5567902560	1.4552E-11	0.08102365	0.202516123

Inspection of **Tables 31** and **32** reveal that 8 and 11 Beta-Gamma differences were contrary to the hypothesis. The probabilities of that happening by chance alone being 0.0006 and 0.01 respectively. Thus, as with the results for the total sample of students, in 28 results of the male sample, the Beta–Gamma differences support the hypothesis that a change in the level of achievement causes an opposite change in the level of anxiety experienced. The 25 Beta–Gamma differences for the female sample can be said to also support the hypothesis as the probability of these results happening by chance alone is about 1.4% - roughly one chance in 70. These and other probabilities are shown in **Table 33**.

The criteria for assuming causation having been met, it is with considerable confidence that it can be said that as a result of the strong relationship between achievement and anxiety, any changes in achievement causes an opposite change in anxiety.

The Beta-Gamma differences, as prescribed by Rogosa, confirm the direction of causation for each of the three samples.

With respect to the total sample, of the twenty-eight Beta-Gamma differences favouring causation in the direction of achievement over anxiety, only four were less than – 0.10, the remainder ranging from – 0.10 to – 0.44.

Closer inspection of **Table 30** shows that the Beta-Gamma differences between period 1 and periods 2 to 9 were all in the direction of lack of achievement causing anxiety. Similar results were obtained with respect to period 2 and periods 3 to 9, period 3 coupled with periods 5, 6, 7 and 9 and period 6 with periods 7, 8 and 9.

The Beta-Gamma differences of period 5 coupled with periods 6, 7 and 8 were positive indicating that the direction of causation was in the direction of anxiety causing lack of achievement. Period 5 equates to the first semester of year 8. Periods 6, 7 and 8 correspond to the second semester of year 8 and the first and second semesters of year 9. As to why there should be a reversal in direction of causation during these successive periods, commencing semester 1, year 8, remains a mystery, as no logical reason could be determined. However, it should be noted that, as the first semester in the 'secondary' school was marked by a large influx of new students, the interaction of these new students with the students already participating in the study may have had some effect.

Table 31 shows a similar pattern of results for the male student sample. In twenty-six instances the Beta-Gamma differences were in the direction of lack of achievement influencing an increase in anxiety or an improvement in the level of achievement influencing a decrease in anxiety. The Beta-Gamma differences ranged from a high of – 0.60, (period 2, and period 4) to the very small difference of – 0.03 in favour of achievement over anxiety (period 1 and period 8).

The eight differences showing a preponderance of anxiety over achievement ranged from a high of 0.30 to a low of 0.02 for the same sample.

Examination of the female sample results as shown in **Table 32** shows an almost identical pattern with twenty-five Beta-Gamma differences in the direction of changes in achievement presupposing opposite changes in the level of anxiety. The differences range from a high of – 0.38 (period 1 with period 3) to a low of – 0.01 (period 3 with period 4).

Considering successive periods throughout the study, with respect to the total sample, four of the eight differences were such that the changes in achievement influenced the opposite changes in anxiety. In the male sample, again four of the differences showed that changes in achievement were followed by the opposite changes in anxiety and in the female sample, six of the eight showed the preponderances of achievement over anxiety.

However, only in the successive periods of 5 and 6 was the direction of causation such that changes in anxiety presupposed changes in achievement for the total, male and female samples. These time period correspond to the first and second semesters correlation differences at year 8 level.

With respect to the Spearman rank correlations between achievement and anxiety as shown in **Tables 21, 22 and 23**, the majority of the cross-lagged correlations indicated that achievement at time 1 influenced anxiety at a later period. The correlations were not only overwhelmingly moderate to strong but also the levels of significance were greater than $p \leq 0.01$ throughout.

Chapter 9

Conclusions and Suggestions for Further Study

The relationship between achievement and anxiety throughout the five years of the study was a negative and significant correlation for the total sample, the male sample and the female sample of students. The cross-lagged panel analysis determined that any changes in the students' levels of achievement resulted in the opposite changes in anxiety.

The results confirm the studies of the earlier researchers who too found that a negative correlation existed between achievement in mathematics and anxiety in mathematics. In many of these earlier studies the students were at university and the studies were carried out over short periods of time, the durations varying from one year to one semester. To my knowledge no study of this type examined the relationship between achievement and anxiety over an extended period of time, with the same students taking part.

Turning to the Drive Theory of Spence (1960) and Spence and Spence (1966), the first construct (Habit-Strength, H) refers to one's existing tendency to respond to a particular situation. A person making the wrong association more often than making the correct association may develop anxiety towards such situations in which a choice has to be made. In addition, if past experience is also taken into consideration, the incorrect response is more likely to be made.

The second construct in Spence's Theory is called Drive (D) which has the capacity to activate the behaviour of the learner. According to Spence, the effects of the Drive construct will depend on the degree of difficulty of the task. In simple tasks where the correct response is more likely to be given, high Drive will facilitate performance, but in the more complex situations, an incorrect answer is more likely to be given and a high level of Drive will impair performance.

In the results of this longitudinal study, although there was a negative relationship between anxiety and achievement at all test periods, high levels of anxiety were not always associated with low levels of achievement. Within each of the three distinct samples there were instances in which high anxiety was associated with high achievement and low anxiety associated with low achievement. Hence, the results did not entirely replicate the results obtained by Spence. On the other hand, Spence was carrying out his research with the use of animals and was testing one situation at a time. In this study, although the topic was confined to mathematics anxiety and achievement, there was a range of different situations within the topic. For example, achievement topics included arithmetic, algebra, geometry and probability, but there was no analysis carried out on these specific areas let alone analysis of the subsections within each of the different areas. Similarly with respect to the topics within each anxiety scale, there was no analysis made of the different subsections.

In an earlier study Spence and Taylor(1951) used the Manifest Anxiety Scale to determine the levels of anxiety. He concluded that high levels of anxiety interfered with the solving of difficult tasks. The results obtained in this present study contradict his findings. Anxiety is not a cause of low achievement but low achievement causes high anxiety.

Similarly, the findings of this study contradict the two hypotheses of anxiety penned by Sarason et al (1960). He states that anxiety will interfere with performance, and the greater the anxiety the greater the interference. The current results show that it is the lack of achievement in mathematics which causes the increase of mathematics anxiety.

Sinclair (1969), as a result of his research found that '*in important examinations the high anxiety student will be at a considerable disadvantage…anxiety will act to interfere with and reduce the level of his performance.*'(p. 305). The findings of this study do not support those of Sinclair. It is the students' low level of performance, which will cause his or her level of anxiety to rise. In other words, the student's levels of preparedness will cause his or her anxiety levels to increase.

Cowen et al's (1963) research results indicated that anxiety measures related negatively to arithmetic reasoning, arithmetic concepts and arithmetic computation for boys and girls at year three level. The results from this longitudinal study using boys and girls from years 6 through to year 10 support Cowen's findings. Also the results of this study are in agreement with the Deficits Theory of Tobias (1985) in so far as poor performance causes anxiety. She attributed the low scores of test anxiety students to poor study habits and/or deficient test-taking skills. The author (Wither) of this study attributes a student's high level of anxiety, not only to possible poor study habits and/or a deficiency in test-taking skills but also, to the possible lack of motivation in the field of mathematics. In addition, a failure to understand the usefulness of mathematics in future work or career paths; or to never having enjoyed the solving of mathematical problems may also contribute to a student's increasing levels of anxiety.

The four hypotheses put forward as possible answers to the four questions posed concerning mathematics achievement and mathematics anxiety among years 6 to 10 students have been found to be valid. In other words:

◊ *Mathematics anxiety was found to exist at a meaningful and significant level at year 6 through to year 10.*

◊ *The correlations between anxiety and achievement were meaningful, significant and in the negative direction throughout the nine test periods.*

◊ *The preponderance of achievement over anxiety was measurable at meaningful and significant levels throughout the duration of the study.*

◊ *The direction of causation was such that lack of achievement caused an increase in anxiety or an increase in achievement caused a decrease in anxiety.*

The **Beta-Gamma** differences were significant for the total sample, the male sample and the female sample. In the case of the total sample, probability of the relationship occurring by chance alone was 0.0006.

Similarly the **Beta-Gamma** differences for the male sample occurring by chance alone was 0.0006, and for the female group of students the chances of the differences occurring by chance alone was 0.01.

The present results provide the best available evidence for the assumption that achievement levels affected anxiety levels in the areas of primary and secondary school mathematics. The fact that achievement has a stronger relationship to subsequent anxiety towards mathematics than anxiety has towards subsequent levels of achievement in mathematics implies that achievement has a causal effect on anxiety. In other words, as the correlations between achievement and anxiety are in the negative direction, the lower the level of achievement, the higher the level of anxiety and an increase in the level of achievement brings about a decrease in the student's anxiety level.

Implications for Teaching and Further Study.

Lund (1953) in his research found that when test questions were carefully graded in degree of difficulty, the anxious students performed at a higher level when they were confronted by easy questions early in the test paper. Thus, carefully graded questions will enable anxious students to answer correctly the first few easier questions, anxiety levels will decrease enabling them more easily to concentrate on the mathematical tasks on hand. This is likely to lead to higher results in the test.

Should a year level class be composed of students having a wide range of mathematical abilities, each test could be constructed in such a manner that the last question(s) in each section of the paper could be optional.

A number of questions in the textbooks, and those prepared by the classroom teacher, should be seen to be relevant to the everyday life of the student. The examples could be related to shopping, travelling, housing finance, banking, building, owning and operating a car or even space travel. The history, social and aesthetic qualities of mathematics should also be taught and explained. (Scopes, 1973; Wither, 1987).

There should also be a sense of enjoyment in the attempting and solving of mathematical problems. The students should feel a sense of accomplishment having solved a mathematical problem correctly, and they should be encouraged to tackle each question in a number of different ways.

Every effort should be made to illustrate correct, or even incorrect solutions with the aid of charts or diagrams. A mathematical '*picture*' can be a powerful tool and teachers and authors should encourage students to develop their visual interpretation of all mathematical problems.

The teaching of mathematics by teachers who enjoy mathematics is a 'prime determiner' of students' attitudes and performance in the subject. As Banks (1964) observes:

An unhealthy attitude towards arithmetic may result from a number of causes. But by far the most significant contributing factor is the attitude of the teacher. The teacher who feels insecure, who dreads and dislikes the subject, and for whom arithmetic is largely rote manipulation, devoid of understanding, cannot avoid transmitting his feelings to the children. On the other hand, the teacher who has confidence, understanding, *interest and enthusiasm for arithmetic has gone a long way toward insuring success. (pp 16 - 17)*

The results of numerous studies support Banks' assertion, and the results of this study re-enforces that assertion in so far as an increase in achievement will result in a decline in the level of the student's anxiety level. Phillips (1990) stresses that the positive, effective and appreciative attitude of the most current teacher of mathematics is significantly related to student attitude.

Banks (1964) also stated that as a child's first experiences with arithmetic usually occur at home with the involvement of his or her parents, one might expect that the attitudes of the parents, and their abilities in mathematics would affect those of their children. Other researchers (Burbank, 1968, Hill; 1968; Sarason, 1972) have reached similar conclusions. Thus, the encouragement of parents to take an active interest in their children's homework exercises and projects should help, in some small way, to increase the interest of the student in the area of mathematics. This, in turn, may increase the student's level of achievement with a possible resultant decline in their level of anxiety.

Some overbearing, or even anxious, parents may increase this level of anxiety.

A number of researchers, Banks included, have also indicated that peer attitudes towards mathematics will have an effect upon the student's attitude. Thus, it is important that the attitude in the classroom is warm, inviting, positive and friendly.

Attitudes towards arithmetic and mathematics can be improved by counselling, enrichment, provision for success experiences, special courses, teaching methods, mathematical games, use of children's literature and language arts analogues, and exposure to people who use mathematics in their jobs (Aiken, 1972.)

Suggestions for Further Study.

This longitudinal study examined the relationship between mathematics achievement and mathematics anxiety from year 6 in the primary school to year 10 in the secondary school. The results showed that the level of achievement had a greater influence on the level of anxiety than anxiety exerted on achievement at all year levels.

Further studies could be considered to examine the significance of the relationship between achievement in mathematics and the student's enjoyment of mathematics; the student's perceived usefulness of mathematics; and the student's perceived value of mathematics (Hermans, 1970, Wither, 1987). The relationship between achievement and perseverance may also be an area worthy of consideration in future research (Wither, 1987). A further examination of peer influence on achievement (Banks, 1968; Hill, 1968; Sarason, 1972) and parental influence with respect to their interest in, and assistance with, their children's homework. (Aiken, 1972), may also be carried out.

In each of the studies the presence of a possible preponderance factor would be sought.

As a result, the emphases on the teaching of mathematics should be changed in order that each student's achievement in mathematics is encouraged and fostered. The students should be assisted whenever possible, giving encouragement to persevere with difficult problems and to attempt a problem in any number of ways.

The texts and examples in mathematics books could probably be written to include:

- ◊ Carefully graded examples
- ◊ Carefully graded questions in all sections of the course
- ◊ A greater number of examples in order that patterns can berecognized
- ◊ Examples having relevance to everyday situations
- ◊ Examples which students will enjoy solving or attempting to solve
- ◊ Examples to encourage lateral thinking
- ◊ Examples with diagrams and charts included
- ◊ Examples which will encourage the use of previously taught mathematical skills as well as the opportunity to use current knowledge and skills.

Also:

- ◊ Preferably, mathematics classes to be taught by teachers who enjoy and value mathematics.

◊ Teachers of mathematics be encouraged to have a sound background of mathematical skills, ideas and methodology far beyond that required in any class.

◊ Teachers should make every effort to encourage the students to develop a sound base for future study in the field of mathematics.

Teachers preparing questions to be used in the classroom should be mindful of the weaker student who is most likely to be highly anxious. The questions should be graded from easiest to most difficult and the number of questions should be such that the majority of the students will complete the questions and achieve a reasonable proportion of success. Authors of textbooks for students at years 6 to 10 must also write their books with highly anxious students as well as high achieving students in mind. The writers should include in each section of the course a set of clearly explained, and carefully worded, examples. The associated problems should be carefully graded from easiest to most difficult. There should be a sufficient number of graded examples in order that the low achieving students will be able to obtain sufficient practice in any area of a particular topic, in order to show that that section of the course is fully understood.

Teachers should have all concepts, rules and methods at their fingertips in order that they too can exude confidence and enjoyment in the solving of mathematics problems. With respect to the many ways of tackling a problem, it may be appropriate that the classroom teacher and the authors of textbooks should endeavour to stress that generally there is more than one method available to solve any problem. Should a student present a solution, which displays a novel approach to the correct solution of a problem, that student could be complimented on the approach and other members of the class should be encouraged to think laterally too.

As the knowledge and understanding of mathematical ideas and concepts develop and increase in the mind of each student, then it could be appropriate that the teachers, as well as the authors of the textbooks, encourage the students to use their newly acquired skills. There should be sufficient exposure to the application of these areas of knowledge so that the students may have every opportunity to practice their newfound skills. Thereby increasing the probability that the solutions to an increasing number of situations and problems may be solved using their ever-increasing knowledge of mathematical theorems, concepts and procedures.

The teaching of mathematics at the primary school level, and indeed at all levels, should allow all students the opportunities to understand fully the concepts of a particular topic and to grasp with confidence the procedures necessary for the correct solution, or solutions, to a problem.

Teachers should also assist and encourage students to develop a sound base on which to build future studies in mathematics. The structure of each topic and each lesson should be such that students are encouraged to develop their skills in accordance with Bloom's taxonomy (Bloom, 1956) of student learning.

Further studies of this type could examine specific areas of arithmetic and mathematics that create lack of achievement and an increase in anxiety in the student population.

The research questions could be:

◊ Does the lack of addition, subtraction, multiplication and division skills of integer numbers cause an increase in anxiety?

◊ Does the lack of addition, subtraction, multiplication and division skills with respect to fractions cause an increase in anxiety?

◊ Does the algebraic concept of the unknown quantity 'x' cause anxiety?

◊ Does the lack of skills with respect to the addition, subtraction, multiplication and division processes associated with 'x' cause anxiety?

◊ Does the increase in the number of examples available for reference assist in the increase of achievement?

◊ Does an increase in the number of graded questions result in an increase in achievement?

◊ Does a lack of enthusiasm for mathematics cause a decrease in achievement?

◊ Does an understanding of the usefulness of mathematics increase one's achievement?

◊ Does an understanding of the value of mathematics increase one's achievement in mathematics?

◊ Does achievement in mathematics depend on the level of persistence with mathematical problems?

◊ Does the enthusiasm of the teacher influence one's level of attainment in mathematics?

◊ Does the competence of the teacher influence the students' levels of achievement in mathematics?

APPENDIX A

Table 41

Histogram of the Mathematics Achievement Test 6A Undertaken by All Year 6 Students

Count	Range	One Symbol For Each Occurrence
5	0 - 13	*****
4	14 - 18	****
3	19 - 23	***
10	24 - 28	**********
14	29 - 33	**************
6	34 - 38	******
8	39 - 43	********
7	44 - 48	*******
13	49 - 53	*************
18	54 - 58	******************
12	59 - 63	************
15	64 - 68	***************
8	69 - 73	********
9	74 - 78	*********
13	79 - 83	*************
7	84 - 88	*******
4	89 - 93	****

Mean	53.73	Mode	31.58	Std. Dev.	21.04
Skewness	-0.21	Minimum	8.78	Maximum	92.98
Valid cases	156	Missing cases	0		

APPENDIX A

Table 42

Histogram of Mathematics Achievement Test 6B Undertaken by All Year 6 Students.

Count	Range	One Symbol For Each Occurrence
1	0 - 3	*
0	4 - 8	
1	9 - 3	*
2	14 - 18	**
4	19 - 23	****
6	24 - 28	******
10	29 - 33	**********
8	34 - 38	********
15	39 - 43	***************
14	44 - 48	**************
7	49 - 53	*******
21	54 - 58	*********************
13	59 - 63	*************
16	64 - 68	****************
13	69 - 73	*************
14	74 - 78	**************
13	79 - 83	*************
3	84 - 88	***
6	89 - 93	******

Mean	55.03	Mode	52.63	St. Dev.	19.21
Skewness	-0.26	Minimum	0.00	Maximum	89.47
Valid Cases	167	Missing Cases 0			

APPENDIX A

Table 43

Histogram of Mathematics Achievement Test 7A Undertaken

By All Year 7 Students

Count	Mid point	One Symbol Equals Approx 0.6 Occurrences
2	0 - 4	***
10	5 - 9	*****************
7	10 - 14	************
9	15 - 19	***************
22	20 - 24	*************************************
27	25 - 29	***
29	30 - 34	**
13	35 - 39	**********************
14	40 - 44	***********************
20	45 - 49	*********************************
7	50 - 54	************
4	55 - 59	*******
7	60 - 64	************
7	65 - 69	************
4	70 - 74	*******
0	75 - 79	
1	80 - 84	**

Mean	37.72	Mode	30.91	Std. Dev.	16.51
Skewness	0.43	Minimum	1.82	Maximum	85.46
Valid Cases	183	Missing Cases 0			

APPENDIX A

Table 44

Histogram of Mathematics Achievement Test 7B Undertaken by All Year 7 Students.

Count	Range	One Symbol For Each Occurrence
1	0 - 10	*
6	9 - 14	******
11	15 - 18	***********
21	19 - 22	*********************
14	23 - 26	**************
28	27 - 30	****************************
19	31 - 34	*******************
5	35 - 38	*****
15	39 - 42	***************
8	43 - 46	********
9	47 - 50	*********
13	51 - 54	*************
8	55 - 58	********
10	59 - 62	**********
3	63 - 66	***
4	67 - 70	****
5	71 - 74	*****
4	75 - 78	****
2	79 - 82	**
0	83 - 86	
1	87 - 90	*

Mean	37.67	Mode	27.27	Std.Dev	17.45
Skewness	0.64	Minimum	9.09	Maximum	87.27
Valid Cases	187	Missing Cases	0		

APPENDIX A

Table 45

Histogram of Mathematics Achievement Test 8A Undertaken by All Year 8 Students.

Count	Range	One Symbol For Each Occurrence.
1	0 - 8	*
3	9 - 12	***
2	13 - 16	**
6	17 - 20	******
18	21 - 24	******************
16	25 - 28	****************
27	29 - 32	***************************
24	33 - 36	************************
26	37 - 40	**************************
39	41 - 44	***************************************
17	45 - 48	*****************
14	49 - 52	**************
15	53 - 56	***************
16	57 - 60	****************
16	61 - 64	****************
11	65 - 68	***********
19	69 - 72	*******************
7	73 - 76	*******
4	77 - 80	****
5	81 - 84	*****
3	85 - 88	***

Mean	44.75	Mode	36.36	Std. Dev.	17.16
Skewness	0.34	Minimum	7.27	Maximum	85.46
Valid Cases	289	Missing Cases	0		

APPENDIX A

Table 46

Histogram of Mathematics Achievement Test 8B Undertaken by All Year 8 Students.

Count	Range	One Symbol For Each Occurrence.
2	0 – 4	**
1	5 – 9	*
3	10 – 14	***
5	15 – 19	*****
4	20 – 24	****
14	25 – 29	**************
20	30 – 34	********************
29	35 – 39	*****************************
11	40 - 44	***********
26	45 – 49	**************************
21	50 – 54	*********************
22	55 – 59	**********************
23	60 – 64	***********************
26	65 – 69	**************************
15	70 – 74	***************
12	75 – 79	************
20	80 – 84	********************
16	85 – 89	****************
9	90 – 94	*********

Mean	53.86	Mode	58.97	Std.Dev	20.25
Skewness	- 0.02	Minimum	0.00	Maximum	92.3
Valid Cases	279	Missing Cases	0		

APPENDIX A

Table 47

Histogram of Mathematics Achievement Test 9A Undertaken by All Year 9 Students.

Count	Range	One Symbol For Each Occurrence.
1	0 - 6	*
3	7 - 10	***
2	11 - 14	**
9	15 - 18	*********
13	19 - 22	*************
32	23 - 26	********************************
21	27 - 30	*********************
22	31 - 34	**********************
24	35 - 38	************************
20	39 - 42	********************
13	43 - 46	*************
15	47 - 50	***************
25	51 - 54	*************************
15	55 - 58	***************
22	59 - 62	**********************
7	63 - 66	*******
4	67 - 70	****
9	71 - 74	*********
9	75 - 78	*********
6	79 - 82	******
2	83 - 86	**

Mean	42.51	Mode	33.33	Std.Dev.	17.69
Skewness	0.33	Minimum	5.56	Maximum	83.33
Valid Cases	274	Missing Cases	2		

APPENDIX A

Table 48

Histogram of Mathematics Achievement Test 9B Undertaken by All Year 9 Students.

Count	Range	One Symbol For Each Occurrence
2	0 - 3	**
0	4 - 8	
6	9 - 13	******
16	14- 18	****************
27	19 - 23	***************************
37	24 - 28	*************************************
21	29 - 33	*********************
29	34 - 38	*****************************
30	39 - 43	******************************
25	44 - 48	*************************
8	49 - 53	********
17	54 - 58	*****************
8	59 - 63	********
7	64 - 68	*******
10	69 - 73	**********
10	74 - 78	**********
6	79 - 83	******
8	84 - 88	********
5	89 - 93	*****

Mean	40.72	Mode	25.46	Std.Dev	20.27
Skewness	0.69	Minimum	0.00	Maximum	90.91
Valid Cases	272	Missing Cases	0		

APPENDIX A

Table 49

Histogram of Mathematics Achievement Test 10A Undertaken by All Year 10 Students.

Count	Range	One Symbol For Each Occurrence.
1	0 - 8	*
0	9 - 12	
3	13 - 16	***
8	17 - 20	********
22	21 - 24	**********************
27	25 - 28	***************************
28	29 - 32	****************************
36	33 - 36	************************************
31	37 - 40	*******************************
38	41 - 44	**************************************
16	45 - 48	****************
13	49 - 52	*************
6	53 - 56	******
10	57 - 60	**********
8	61 - 64	********
6	65 - 68	******
4	69 - 72	****
1	73 - 76	*
2	77 - 80	**
0	81 - 84	
1	85 - 88	*

Mean	38.11	Mode	34.55	Std. Dev.	13.46
Skewness	0.77	Minimum	5.46	Maximum	87.27
Valid Cases	261	Missing Cases	6		

APPENDIX A

Table 50

Histogram of Mathematics Achievement Test 10B Undertaken by All Year 10 Students.

Count	Range	One Symbol For Each Occurrence
3	0 - 10	***
10	11 - 15	**********
20	16 - 20	********************
21	21 - 25	*********************
14	26 - 30	**************
31	31 - 35	*******************************
10	36 - 40	**********
15	41 - 45	***************
11	46 - 50	***********
12	51 - 55	************
11	56 - 60	***********
16	61 - 65	****************
8	66 - 70	********
6	71 - 75	******
4	76 - 80	****
5	81 - 85	*****
1	86 - 90	*
1	91 - 95	*
1	96 - 100	*

Mean	42.98	Mode	34.93	St. Dev.	20.31
Skewness	0.51	Minimum	9.3	Maximum	100
Valid Cases	200	Missing Cases	68		

APPENDIX A

Table 51

Histogram of the Mathematics Achievement Test 6A Undertaken by All Year 6 Male Students.

Count	Range	One Symbol For Each Occurrence.
3	0 - 14	***
3	15 - 19	***
2	20 - 24	**
4	25 - 29	****
10	30 - 34	**********
2	35 - 39	**
2	40 - 44	**
5	45 - 49	*****
6	50 - 54	******
8	55 - 59	********
2	60 - 64	**
9	65 - 69	*********
4	70 - 74	****
6	75 - 79	******
10	80 - 84	**********
4	85 - 89	****
4	90 - 94	****

Mean 55.08 Mode 31.58 Std.Dev. 22.98

Skewness -0.27 Minimum 8.77 Maximum 92.98

Valid Cases 84 Missing Cases 0

APPENDIX A

Table 52

Histogram of Mathematics Achievement Test 6B Undertaken by All Year 6 Male Students.

Count	Range	One Symbol For Each Occurrence.
1	0 – 3	*
0	4 – 8	
0	9 – 13	
2	14 –18	**
2	19 - 23	**
6	24 – 28	******
2	34 – 38	**
7	39 – 43	*******
6	44 – 48	******
4	49 – 53	****
11	54 – 58	***********
8	59 – 63	********
4	64 - 68	****
8	69 – 73	********
9	74 – 78	*********
7	79 – 83	*******
3	84 – 88	***
4	89 - 93	****

Mean	55.82	Mode	75.44	Std.Dev	20.63
Skewness	- 0.38	Minimum	0.00	Maximum	89.47
Valid Cases	88	Missing Cases	0		

APPENDIX A

Table 53

Histogram of Mathematics Achievement Test 7A Undertaken by All Year 7 Male Students.

Count	Range	One Symbol For Each Occurrence.
2	0 – 7	**
5	8 – 12	*****
4	13 – 17	****
0	18 – 22	
14	23 – 27	**************
12	28 – 32	************
12	33 – 37	************
4	38 – 42	****
5	43 – 47	*****
12	48 - 52	************
5	53 – 57	*****
2	58 – 62	**
7	63 – 67	*******
4	68 – 72	****
2	73 – 77	**
0	78 – 82	
1	83 - 87	*

Mean	11.5 9	Mode	6.92	Std.Dev.	10.47
Skewness	1.46	Minimum	0.00	Maximum	84.40
Valid Cases	91	Missing Cases 0			

APPENDIX A

Table 54

Histogram of Mathematics Achievement Test 7B Undertaken by All Year 7 Male Students.

Count	Range	One Symbol For Each Occurrence
1	0 - 12	*
2	13 - 16	**
6	17 - 20	******
14	21 - 24	**************
12	25 - 28	************
15	29 - 32	***************
3	33 - 36	***
2	37 - 40	**
7	41 - 44	*******
4	45 - 48	****
5	49 - 52	*****
5	53 - 56	*****
9	57 - 60	*********
2	61 - 64	**
3	65 - 68	***
1	69 - 72	*
3	73 - 76	***
0	77 - 80	
1	81 - 84	*

Mean	38.01	Mode	27.27	Std.Dev	16.98
Skewness	0.60	Minimum	10.91	Maximum	81.82
Valid Cases	95	Missing Cases	0		

APPENDIX A

Table 65

Histogram of Mathematics Achievement Test 8A Undertaken by All Year 8 Male Students.

Count	Range	One Symbol For Each Occurrence.
2	0 - 11	**
3	12 - 15	***
5	16 - 19	*****
9	20 - 23	*********
6	24 - 27	******
13	28 - 31	*************
15	32 - 35	***************
16	26 - 39	****************
10	40 - 43	**********
8	44 - 47	********
14	48 - 51	***************
5	52 - 55	*****
5	56 - 59	*****
4	60 - 63	****
4	64 - 67	****
13	68 - 71	**************
3	72 - 75	***
1	76 - 79	*
3	80 - 83.	***
3	84 - 87	***

Mean	45.25	Mode	40.00	Std. Dev.	18.22
Skewness	0.38	Minimum	9.09	Maximum	85.46
Valid Cases	142	Missing Cases 0			

APPENDIX A

Table 56

Histogram of Mathematics Achievement Test 8B Undertaken by All Year 8 Male Students.

Count	Range	One Symbol For Each Occurrence
1	0 – 13	*
1	14 – 18	*
2	19 – 23	**
5	24 – 28	*****
7	29 – 33	*******
12	34 – 38	************
8	39 – 43	********
14	44 – 48	**************
9	49 – 53	*********
10	54 – 58	**********
14	59 – 63	**************
15	64 – 68	***************
7	69 – 73	*******
7	74 – 78	*******
11	79 – 83	***********
7	84 – 88	*******
3	89 – 93	***

Mean	55.18	Mode	43.59	Std.Dev	19.29
Skewness	- 0.05	Minimum	7.69	Maximum	92.31
Valid Cases	133	Missing Cases	0		

APPENDIX A

Table 57

Histogram of Mathematics Achievement Test 9A Undertaken by All Year 9 Male Students.

Count	Range	One Symbol For Each Occurrence.
1	0 - 12	*
1	13 - 16	*
6	17 - 20	******
7	21 - 24	*******
14	25 - 28	**************
5	29 - 32	*****
12	33 - 36	************
3	37 - 40	***
9	41 - 44	*********
3	45 - 48	***
11	49 - 52	***********
9	53 - 56	*********
9	57 - 60	*********
8	61 - 64	********
3	65 - 68	***
4	69 - 72	****
9	73 - 76	*********
2	77 - 80	**
5	81 - 84	*****

Mean	46.27	Mode	24.07	Std, .Dev.	19.28
Skewness	0.15	Minimum	9.26	Maximum	83.33
Valid Cases	121	Missing Cases	2		

APPENDIX A

Table 58

Histogram of Mathematics Achievement Test 9B Undertaken by All Year 9 Male Students.

Count	Range	One Symbol For Each Occurrence
2	0 – 3	**
0	4 –8	
3	9 – 13	***
4	14 - 18	****
5	19 – 23	*****
17	24 – 28	*****************
12	29 – 33	************
15	34 – 38	***************
14	39 – 43	**************
9	44 – 48	*********
2	49 – 53	**
9	54 – 58	*********
5	59 – 63	*****
3	64 – 68	***
3	69 – 73	***
7	74 – 78	*******
5	79 – 83	*****
8	84 – 88	********
4	89 – 93	****

Mean	45.11	Mode	25.46	Std.Dev	22.57
Skewness	0.48	Minimum	0.00	Maximum	90.91
Valid Cases	127	Missing Cases	0		

APPENDIX A

Table 59

Histogram of Mathematics Achievement Test 10A Undertaken by All Year 10 Male Students.

Count	Range	One Symbol For Each Occurrence.
3	0 - 17	***
7	18 - 21	*******
9	22 - 25	*********
15	26 - 29	***************
20	32 - 33	********************
15	34 - 37	***************
8	38 - 41	********
10	44 - 45	**********
6	46 - 49	******
9	50 - 53	*********
3	54 - 57	***
5	58 - 61	*****
2	62 - 65	**
2	66 - 69	**
4	70 - 73	****
1	74 - 77	*
1	78 - 81	*
0	82 - 85	
1	86 - 89	*

Mean	38.33	Mode	34.55	Std. Dev.	15.04
Skewness	0.94	Minimum	14.55	Maximum	87.27
Valid Cases	121	Missing Cases	6		

APPENDIX A

Table 60

Histogram of Mathematics Achievement Test 10B Undertaken by All Year 10 Male Students

Count	Range	One Symbol For Each Occurrence
3	0 – 13	***
7	14 – 18	*******
9	19 – 23	*********
11	24 – 28	***********
7	29 – 33	*******
16	34 – 38	****************
4	39 – 43	****
5	44 – 48	*****
4	49 – 53	****
7	54 – 58	*******
4	59 – 63	****
7	64 – 68	*******
5	69 – 73	*****
4	74 – 78	****
3	79 – 83	***
3	84 – 88	***
1	89 – 93	*
1	94 – 98	*
1	99 - 100	*

Mean	43.53	Mode	23.26	Std.Dev	22.50
Skewness	0.52	Minimum	9.30	Maximum	100.00
Valid Cases	102	Missing Cases	30		

APPENDIX A

Table 61

Histogram of the Mathematics Achievement Test 6A Undertaken by All Year 6 Female Students.

Count	Range	One Symbol For Each Occurrence
3	0 - 16	***
0	17 - 20	
0	21 - 24	
3	25 - 28	***
7	29 - 32	*******
2	33 - 36	**
5	37 - 40	*****
3	41 - 44	***
2	45 - 48	**
3	49 - 52	***
8	53 - 56	********
11	57 - 60	***********
5	61 - 64	*****
4	65 - 68	****
6	69 - 72	******
3	73 - 76	***
1	77 - 80	*
2	81 - 84	**
3	85 - 88	***

Mean	52.63	Mode	59.65	Std. Dev.	18.27
Skewness	-0.22	Minimum	12.28	Maximum	87.72
Valid Cases	71	Missing Cases	0		

APPENDIX A

Table 62

Histogram of Mathematics Achievement Test 6B Undertaken By All Year 6 Female Students

Count	Range	One Symbol For Each Occurrence
1	0 - 12	*
0	13 - 16	
2	17 - 20	**
0	21 - 24	
0	25 - 28	
6	29 - 32	******
4	33 - 36	****
7	37 - 40	*******
8	41 - 44	********
3	45 - 48	***
3	49 - 52	***
6	53 - 56	******
6	57 - 60	******
9	61 - 64	*********
6	65 - 68	******
5	69 - 72	*****
3	73 - 76	***
5	77 - 80	*****
3	81 - 84	***
1	85 - 88	*
1	89 - 92	*

Mean	54.14	Mode	63.16	Std.Dev	17.57
Skewness	- 0.11	Minimum	10.53	Maximum	89.47
Valid Cases	79	Missing Cases	0		

APPENDIX A

Table 63

Histogram of Mathematics Achievement Test 7A Undertaken by All Year 7 Female Students.

Count	Range	One Symbol For Each Occurrence.
2	0 – 8	**
3	9 – 12	***
3	13 – 15	***
2	16 – 18	**
7	19 – 21	*******
4	22 – 25	****
8	26 – 28	********
11	29 – 31	***********
12	32 – 35	************
8	36 – 38	********
6	39 – 41	******
7	42 – 45	*******
6	46 – 48	******
4	49 – 51	****
1	52 – 55	*
2	56 – 58	**
1	59 – 61	*
0	62 – 65	
2	66 – 68	**
1	69 – 71	*
2	72 - 75	**

Mean	34.64	Mode	20.00	Std. Dev.	14.46
Skewness	0.55	Minimum	7.27	Maximum	72.73
Valid Cases	92	Missing Cases	0		

APPENDIX A

Table 64

Histogram of Mathematics Achievement Test 7B Undertaken by All Year 7 Female Students.

Count	Range	One Symbol For Each Occurrence
1	0 - 10	*
3	11 - 14	***
7	15 - 18	*******
10	19 - 22	**********
7	23 - 26	*******
12	27 - 30	************
8	31 - 34	********
4	35 - 38	****
8	39 - 42	********
4	43 - 46	****
5	47 - 50	*****
8	51 - 54	********
2	55 - 58	**
3	59 - 62	***
1	63 - 66	*
1	67 - 70	*
5	71 - 74	*****
1	75 - 78	*
1	79 - 82	*
0	83 - 86	
1	87 - 90	*

Mean	37.31	Mode	27.27	Std.Dev	18.00
Skewness	0.70	Minimum	9.09	Maximum	87.27
Valid Cases	92	Missing Cases	0		

APPENDIX A

Table 65

Histogram of Mathematics Achievement Test 8A Undertaken by All Year 8 Female Students.

Count	Range	One Symbol For Each Occurrence.
2	0 - 10	**
1	11 - 14	*
0	15 - 18	
4	19 - 22	****
10	23 - 26	**********
12	27 - 30	************
18	31 - 34	******************
16	35 - 38	****************
10	39 - 42	**********
15	43 - 46	***************
9	47 - 50	*********
5	51 - 54	*****
9	55 - 58	*********
10	59 - 62	***********
9	63 - 66	**********
6	67 - 70	******
6	71 - 74	******
3	75 - 78	***
2	79 - 82	*

Mean	44.28	Mode	36.36	Std.Dev.	16.12
Skewness	0.27	Minimum	7.27	Maximum	80.00
Valid Cases	147	Missing Cases	0		

APPENDIX A

Table 66

Histogram of Mathematics Achievement Test 8B Undertaken by All Year 8 Female Students.

Count	Range	One Symbol For Each Occurrence
2	0 - 3	**
0	4 - 8	
3	9 - 13	***
3	14 - 18	***
2	19 - 23	**
5	24 - 28	*****
12	29 - 33	************
17	34 - 38	*****************
9	39 - 43	*********
12	44 - 48	************
12	49 - 53	************
12	54 - 58	************
9	59 - 63	*********
11	64 - 68	***********
8	69 - 73	********
5	74 - 78	*****
9	79 - 83	*********
9	84 - 88	*********
6	89 - 93	******

Mean 52.65 Mode 35.90 Std.Dev 21.08

Skewness 0.03 Minimum 0.00 Maximum 92.31

Valid Cases 146 Missing Cases 0

APPENDIX A

Table 67

Histogram of Mathematics Achievement Test 9A Undertaken by All Year 9 Female Students.

Count	Range	One Symbol For Each Occurrence.
1	0 - 9	*
4	10 - 13	****
6	14 17	******
6	18 - 21	******
10	22 - 25	**********
13	26 - 29	*************
12	30 - 33	************
19	34 - 37	*******************
24	38 - 41	************************
3	42 - 45	***
11	46 - 49	***********
7	50 - 53	*******
11	54 - 57	***********
10	58 - 61	**********
6	62 - 65	******
2	66 - 69	**
4	70 - 73	****
1	74 - 77	*
2	78 - 81	**

Mean	39.55	Mode	38.89	Std.Dev.	15.81
Skewness	0.33	Minimum	5.56	Maximum	79.63
Valid Cases	152	Missing Cases	0		

APPENDIX A

Table 68

Histogram of Mathematics Achievement Test 9B Undertaken by All Year 9 Female Students.

Count	Range	One Symbol For Each Occurrence
3	0 - 12	***
7	13 - 16	*******
7	17 - 20	*******
24	21 - 24	************************
16	25 - 28	****************
9	29 - 32	*********
10	33 - 36	**********
9	37 - 40	*********
16	41 - 44	****************
11	45 - 48	***********
6	49 - 52	******
6	53 - 56	******
3	57 - 60	***
3	61 - 64	***
3	65 - 68	***
7	69 - 72	*******
3	73 - 76	***
1	74 - 80	*
0	81 - 84	
0	85 - 88	
1	89 - 92	*

Mean	36.88	Mode	20.00	Std.Dev	17.19
Skewness	0.70	Minimum	10.91	Maximum	89.09
Valid Cases	145	Missing Cases	0		

APPENDIX A

Table 69

Histogram of Mathematics Achievement Test 10A Undertaken by All Year 10 Female Students.

Count	Range	One Symbol For Each Occurrence.
1	0 - 5	*
0	6 - 9	
0	10 - 12	
1	13 - 15	*
5	16 - 19	*****
5	20 - 22	*****
10	23 - 25	**********
5	26 - 29	*****
15	30 - 32	***************
19	33 - 35	*******************
21	36 - 39	*********************
18	40 - 42	******************
12	43 - 45	************
5	46 - 49	*****
4	50 - 52	****
3	53 - 55	***
6	56 - 59	******
3	60 - 62	***
3	63 - 65	***
2	66 - 69	**
1	70 - 72	*

Mean	37.82	Mode	38.18	Std. Dev.	11.98
Skewness	0.44	Minimum	5.46	Maximum	69.09
Valid Cases	139	Missing Cases	0		

APPENDIX A

Table 70

Histogram of Mathematics Achievement Test 10B Undertaken by All Year 10 Female Students.

Count	Range	One Symbol For Each Occurrence
2	0 - 16	**
5	17 - 20	*****
10	21 - 24	**********
13	25 - 28	*************
1	29 - 32	*
10	33 - 36	**********
10	37 - 40	**********
1	41 - 44	*
10	45 - 48	**********
7	49 - 52	*******
5	53 - 56	*****
3	57 - 60	***
8	61 - 64	********
5	65 - 68	*****
1	69 - 72	*
3	73 - 76	***
2	77 - 80	**
1	81 - 84	*
1	85 - 88	*

Mean	42.41	Mode	32.56	Std.Dev	17.84
Skewness	0.43	Minimum	13.95	Maximum	86.05
Valid Cases	98	Missing Cases	0		

APPENDIX A

Table 71

Histogram of Mathematics Anxiety Scale 6A Undertaken by All Year 6 Students.

Count	Range	One Symbol For Each Occurrence
27	0 - 4	***************************
18	5 - 7	******************
19	8 - 10	*******************
23	11 - 13	***********************
17	14 - 16	*****************
13	17 - 19	*************
12	20 - 22	***********
6	23 - 25	******
9	26 - 28	*********
1	29 - 31	*
6	32 - 34	******
5	35 - 37	*****
2	38 - 40	**
0	41 - 43	
1	44 - 46	*
3	47 - 49	***
0	50 - 52	
2	53 - 55	**
1	56 - 58	*
2	59 - 61	*

Mean	16.14	Mode	10.64	Std. Dev.	12.87
Skewness	1.36	Minimum	0.00	Maximum	59.57
Valid Cases	167	Missing Cases	0		

APPENDIX A

Table 72

Histogram of the Mathematics Anxiety Rating Scale 6B Undertaken by All Year 6 Students.

Count	Range	One Symbol For Each Occurrence.
12	0 - 4. 5	************
15	5 - 8.0	***************
14	8.5 - 11.5	**************
26	12 - 15.0	**************************
13	15.5 - 18.5	*************
11	19 - 22.0	******************
13	22.5 - 25.5	*************
5	26 - 29.0	*****
11	29.5 - 32.5	***********
10	33 - 36.0	**********
7	36.5 - 39.5	*******
2	40 -43.0	**
3	43.5 - 45.5	***
5	46 - 49.0	*****
3	49.5 - 52.5	***
1	53 - 56.0	*
0	56.5 - 59.5	
0	60 - 63.0	
5	63.5 - 66.5	*****

Mean	20.81	Mode	13.83	Std.Dev.	14.58
Skewness	0.99	Minimum	0.00	Maximum	64.36
Valid cases	156	Missing cases	0		

APPENDIX A

Table 73

Histogram of Mathematics Anxiety Rating Scale 7A

Undergone by All Year 7 Students

Count	Mid point	One Symbol For Each Occurrence
30	0 - 3	******************************
29	4 - 7	*****************************
31	8 - 10	*******************************
22	11 - 13	**********************
14	14 - 17	**************
11	18 - 20	***********
17	21 - 23	*****************
6	24 - 27	******
4	28 - 30	****
6	31 - 33	******
4	34 - 37	****
1	38 - 40	*
2	41 - 43	**
0	44 - 47	
3	48 -50	***
1	51 - 53	*
0	54 - 57	
0	58 - 60	
2	61 - 63	**

Mean	13.76	Mode	1.60	Std. Dev.	11.92
Skewness	1.55	Minimum	0.00	Maximum	63.00
Valid Cases	183	Missing Cases	0		

APPENDIX A

Table 74

Histogram of Mathematics Anxiety Scale 7B Undertaken

by All Year 7 Students.

Count	Range	One Symbol For Each Occurrence
56	0 - 2	*** *********
43	3 - 7	***
34	8 - 12	**********************************
21	13 - 17	*********************
13	18 - 22	*************
5	23 - 27	*****
6	28 - 32	******
4	33 - 37	****
1	38 - 42	*
1	43 - 47	*
1	48 - 52	*
1	53 - 57	*
0	58 - 62	
0	63 - 67	
0	68 - 72	
0	73 - 77	
0	78 - 82	
0	83 - 87	
0	88 - 92	
0	93 - 97	
1	98 - 102	*

Mean	10.11	Mode	0.00	Std.Dev	12.20
Skewness	3.07	Minimum	0.00	Maximum	100.00
Valid Cases	187	Missing Cases	0		

APPENDIX A

Table 75

Histogram of Mathematics Anxiety Scale 8A Undertaken by All Year 8 Students.

Count	Range	One Symbol For Each Occurrence.
49	0 - 5	*** **
75	6 - 10	*** ****************************
59	11 - 15	*** ************
35	16 - 20	***********************************
25	21 - 25	*************************
7	26 - 30	******
8	31 - 35	********
5	36 - 40	*****
5	46 - 45	*****
4	51 - 50	****
7	51 - 55	*******
1	56 - 60	*
2	61 - 65	**
2	66 - 70	**
0	71 - 75	
1	76 - 80	*
0	81 - 85	
0	86 - 90	
0	91 - 95	
1	96 - 100	*

Mean	14.56	Mode	0.00	Std. Dev.	18.68
Skewness	3.26	Minimum	0.00	Maximum	125.00
Valid Cases	289	Missing Cases	0		

APPENDIX A

Table 76

Histogram of Mathematics Anxiety Scale 8B Undertaken by All Year 8 Students.

Count	Range	One Symbol For Each Occurrence
99	0 - 5	***
		***
		***
48	6 - 9	***
		*****
42	10 - 13	**
23	14 - 17	***********************
15	18 - 21	***************
8	22 - 25	********
10	26 - 29	**********
2	30 - 33	**
4	34 - 37	****
5	38 - 41	*****
5	42 - 45	*****
2	46 - 49	**
1	50 - 53	*
1	54 - 57	*
0	58 - 61	
1	62 - 65	*
0	66 - 69	
0	70 - 73	
1	74 - 77	*
1	78 - 81	*

Mean	11.63	Mode	0.00	Std.Dev	12.69
Skewness	2.25	Minimum	0.00	Maximum	78.72
Valid Cases	268	Missing Cases 11			

APPENDIX A

Table 77

Histogram of Mathematics Anxiety Scale 9A Undertaken by All Year 9 Students.

Count	Range	One Symbol For Each Occurrence.
34	0 – 5	**********************************
56	6 – 10	** **************
64	11 – 15	** **********************
35	16 – 20	***********************************
17	21 – 25	*****************
22	26 – 30	**********************
11	31 – 35	***********
5	36 – 40	*****
7	41 – 45	*******
3	46 – 50	**
2	51 – 55	*
2	56 – 60	*
2	61 – 65	*
1	66 – 70	*
1	71 – 75	*
1	76 – 80	*
0	81- 85	
0	86 – 90	
0	91 – 95	
2	96 –100	**

Mean	15.05	Mode	0.00	Std. Dev.	15.21
Skewness	2.36	Minimum	0.00	Maximum	100.00
Valid Cases	265	Missing Cases 11			

APPENDIX A

Table 78

Histogram of Mathematics Anxiety Scale 9B Undertaken by All Year 9 Students.

Count	Range	One Symbol For Each Occurrence
58	0 – 5	**
		********
73	6 – 10	**
		***********************
42	11 – 15	**
31	16 – 20	*******************************
13	21 – 25	*************
12	26 – 30	************
5	31 – 35	*****
10	36 – 40	**********
2	41 – 45	**
3	46 – 50	***
0	51 – 55	
2	56 – 60	**
0	61 – 65	
0	66 – 70	
0	71 – 75	
0	76 – 80	
0	81 – 85	
0	86 – 90	
1	91 – 95	*

Mean	12.45	Mode	8.89	Std.Dev	11.85
Skewness	2.37	Minimum	0.00	Maximum	93.33
Valid Cases	262	Missing Cases	10		

APPENDIX A

Table 79

Histogram of Mathematics Anxiety Scale 10A Undertaken by All Year 10 Students.

Count	Range	One Symbol For Each Occurrence.
21	0 – 2	*********************
30	3 –5	******************************
33	6 –8	*********************************
24	9 –11	************************
36	12 –14	************************************
19	15 – 17	*******************
16	18 – 20	****************
18	21 – 23	******************
18	24 – 26	******************
9	27 – 29	*********
9	30 – 32	*********
5	33 – 35	*****
4	36 – 38	****
2	39 – 41	**
1	42 – 44	*
3	45 – 47	***
2	48 – 50	**
2	51 – 53	**
0	54 – 56	
1	57 – 59	*
2	60 – 62	**

Mean	14.83	Mode	0.00	Std. Dev.	12.06
Skewness	1.24	Minimum	0.00	Maximum	60.64
Valid Cases	255	Missing Cases	12		

APPENDIX A

Table 80

Histogram of Mathematics Anxiety Scale 10B Undertaken by All Year 10 Students.

Count	Range	One Symbol For Each Occurrence
14	0 - 1	**************
26	2 - 4	**************************
23	5 - 7	***********************
21	8 - 10	*********************
13	11 - 13	*************
12	14 - 16	************
13	17 - 19	*************
8	20 - 22	********
5	24 - 25	*****
5	26 - 28	*****
7	29 - 31	*******
4	32 - 34	****
2	35 - 37	**
3	38 - 40	***
1	41 - 43	*
2	44 - 46	**
1	47 - 49	*
0	50 - 52	
1	53 - 55	*
1	56 - 58	*

Mean	14.56	Mode	6.38	St.Dev.	12.06
Skewness	1.18	Minimum	0.00	Maximum	56.92
Valid Cases	162	Missing Cases 106			

APPENDIX A

Table 81

Histogram of Mathematics Anxiety Scale 6A Undertaken

By All Year 6 Male Students

Count	Range	One Symbol For Each Occurrence.
6	0 – 2	******
15	3 – 5	***************
9	6 – 8	*********
10	9 – 11	**********
10	12 – 14	**********
5	15 – 17	*****
6	18 – 20	******
4	21 – 23	****
3	24 – 26	***
7	27 – 29	*******
1	30 – 32	*
4	33 – 35	****
2	36 – 38	**
1	39 – 41	*
0	42 – 44	
0	45 – 47	
2	48 – 50	**
0	51 – 53	
1	54 – 56	*
0	57 – 59	
2	60 – 62	**

Mean	15.57	Mode	0.00	Std.Dev	13.78
Skewness	1.31	Minimum	0.00	Maximum	59.57
Valid Cases	88	Missing Cases	0		

APPENDIX A

Table 82

Histogram of the Mathematics Anxiety Rating Scale 6B Undertaken by All Year 6 Male Students.

Count	Range	One Symbol For Each Occurrence.
8	0 - 4.	********
12	5 - 7.	************
7	8 - 10.	*******
11	11 - 14.	***********
6	15 - 17	******
5	18 - 20.	*****
6	21 - 24.	******
1	25 - 27.	*
4	28 - 30.	****
7	31 - 34.	*******
6	35 - 37.	******
1	39 - 40.	*
2	41 - 44.	**
3	45 - 47.	***
2	48 - 50.	**
0	51 - 54.	
0	55 - 57.	
0	58 - 60.	
3	61 - 64.	***

Mean	20.84	Mode	6.92	Std. Dev.	15.51
Skewness	0.88	Minimum	0.00	Maximum	64.00
Valid Cases	84	Missing Cases		0	

APPENDIX A

Table 83

Histogram of Mathematics Anxiety Scale 7A Undertaken by All Year 7 Male Students.

Count	Range	One Symbol For Each Occurrence.
18	0 – 2	******************
7	3 – 5	*******
22	6 – 8	**********************
10	9 – 11	**********
4	12 – 14	****
3	15 – 17	***
5	18 – 20	*****
2	21 – 23	**
7	24 – 26	*******
4	27 – 29	****
1	30 – 32	*
2	33 – 35	**
2	36 – 38	**
1	39 – 41	*
1	42 – 44	*
1	45 – 47	*
1	48 – 50	*

Mean	11.59	Mode	6.92	Std.Dev.	10.47
Skewness	1.46	Minimum	0.00	Maximum	48.00
Valid Cases	91	Missing Cases	0		

APPENDIX A

Table 84

Histogram of Mathematics Anxiety Scale 7B Undertaken

by All Year 7 Male Students.

Count	Range	One Symbol For Each Occurrence
34	0 – 5	**********************************
27	6 – 10	***************************
13	11 – 15	*************
6	16 – 20	******
6	21 – 25	******
2	26 – 30	**
1	31 – 35	*
3	36 – 40	***
1	41 – 45	*
0	46 – 50	
0	51 – 55	
1	56 – 60	*
0	61 – 65	
0	66 – 70	
0	71 – 75	
0	76 – 80	
0	81 – 85	
0	86 – 90	
0	91 – 95	
1	96 - 100	*

Mean	9.17	Mode	0.00	StdDev	3.74
Skewness	13.94	Minimum	0.00	Maximum	100.00
Valid Cases	95	Missing Cases	0		

APPENDIX A

Table 85

Histogram of Mathematics Anxiety Scale 8A Undertaken by All Year 8 Male Students.

Count	Range	One Symbol For Each Occurrence.
57	0 - 6	*** ****
36	7 - 12	************************************
18	13 - 18	******************
12	19 - 24	************
3	25 - 30	***
4	31 - 36	***
1	37 - 42	*
3	43 - 48	***
3	49 - 54	***
0	55 - 60	
1	61 - 66	*
1	67 - 72	*
1	73 - 78	*
2	79 - 84	**

Mean	14.29	Mode	36.36	Std. Dev.	16.12
Skewness	0.27	Minimum	5.27	Maximum	80.00
Valid Cases	142	Missing Cases	0		

APPENDIX A

Table 86

Histogram of Mathematics Anxiety Scale 8B Undertaken by All Year 8 Male Students.

Score	Range	One Symbol For Each Occurrence
48	0 - 4	**
32	5 - 8	********************************
18	9 - 12	******************
12	13 - 16	************
8	17 - 20	********
6	21 - 24	******
2	25 - 28	**
1	29 - 32	*
0	33 - 36	
0	37 - 40	
2	41 - 44	**
1	45 - 48	*
1	49 - 52	*
0	53 - 56	
0	57 - 60	
0	61 - 64	
0	65 - 68	
0	69 - 72	
1	73 - 76	*

Mean	9.23	Mode	0.00	Std.Dev	10.97
Skewness	2.91	Minimum	0.00	Maximum	75.60
Valid Cases	132	Missing Cases	1		

APPENDIX A

Table 87

Histogram of Mathematics Anxiety Scale 9A Undertaken by All Year 9 Male Students.

Count	Range	One Symbol For Each Occurrence.
24	0 – 2	************************
27	3 – 7	***************************
25	8 – 12	*************************
11	13 – 17	***********
6	18 – 22	******
10	23 – 27	**********
3	28 – 32	***
0	33 – 37	
1	38 – 42	*
1	43 – 47	*
1	48 – 50	*
0	53 – 57	
1	58 – 62	*
0	63 – 67	
0	68 – 72	
0	73 – 77	
0	78 – 82	
0	83 – 87	
0	88 – 92	
1	93 – 97	*
1	98 - 102	*

Mean	12.54	Mode	0.00	Std.Dev.	15.88
Skewness	3.31	Minimum	0.00	Maximum	100.00
Valid Cases	112	Missing Cases	11.		

APPENDIX A

Table 88

Histogram of Mathematics Anxiety Scale 9B Undertaken by All Year 9 Male Students.

Count	Range	One Symbol For Each Occurrence
32	0 – 3	********************************
21	4 – 6	*********************
16	7 – 9	****************
10	10 – 12	**********
5	13 – 15	*****
10	16 – 18	**********
7	19 – 21	*******
2	22 – 24	**
2	25 – 27	**
2	28 – 30	**
4	31 – 33	****
2	34 – 36	**
3	37 – 39	***
2	40 – 42	**
1	43 – 45	*
0	46 – 48	
1	49 – 51	*

Mean	10.34	Mode	1.67	Std.Dev	10.43
Skewness	1.71	Minimum	0.00	Maximum	48.89
Valid Cases	120	Missing Cases	7		

APPENDIX A

Table 89

Histogram of Mathematics Anxiety Scale 10A Undertaken

by All Year 10 Male Students.

Count	Range	One Symbol For Each Occurrence.
22	0 – 2	**********************
10	3 – 5	**********
15	6 – 8	***************
7	9 – 11	*******
9	12 – 14	*********
11	15 – 17	***********
7	18 – 20	*******
7	21 – 23	*******
2	24 – 26	**
10	27 – 29	**********
2	30 – 32	**
3	33 – 35	***
3	36 – 38	***
2	39 – 41	**
2	42 – 44	**
0	45 – 47	
2	48 – 50	**
1	51 - 53	*

Mean	12.98	Mode	0.00	Std.Dev.	11.52
Skewness	1.19	Minimum	0.00	Maximum	52.13
Valid Cases	115	Missing Cases	12		

APPENDIX A

Table 90

Histogram of Mathematics Anxiety Scale 10B Undertaken by All Year 10 Male Students

Count	Range	One Symbol For Each Occurrence
12	0 – 3	************
18	4 – 6	******************
15	7 – 9	***************
11	10 – 12	***********
6	13 – 15	******
5	16 –18	*****
5	19 – 21	*****
2	22 – 24	**
2	25 – 27	**
1	28 – 30	*
3	31 – 33	***
2	34 – 36	**
0	47 – 39	
1	40 – 42	*
0	43 – 45	
1	46 – 48	*
0	49 – 51	
0	52 – 54	
1	55 – 57	*

Mean	11.29	Mode	6.38	Std.Dev	11.07
Skewness	1.77	Minimum	0.00	Maximum	56.92
Valid Cases	85	Missing Cases	47		

APPENDIX A

Table 91

Histogram of the Mathematics Anxiety Rating Scale 6A Undertaken by All Year 6 Female Students.

Count	Range	One Symbol For Each Occurrence.
4	0 – 3	****
2	4 – 6	**
6	7 – 9	******
8	10 – 12	********
13	13 – 15	*************
5	16 – 18	*****
6	19 – 21	******
5	22 – 24	*****
4	25 – 27	****
6	28 – 30	*******
3	31 – 33	***
0	34 – 36	
1	37 – 39	*
1	40 – 42	*
2	43 – 45	**
1	46 – 48	*
1	49 – 51	*
1	52 – 54	*
0	55 – 57	
0	58 – 60	
2	61 – 63	**

Mean	20.65	Mode	13.83	Std. Dev.	13.57
Skewness	1.21	Minimum	1.06	Maximum	62.77
Valid Cases	71	Missing Case	0		

APPENDIX A

Table 92

Histogram of Mathematics Anxiety Scale 6B Undertaken

By All Year 6 Female Students

Count	Range	One Symbol For Each Occurrence
2	0 – 3	**
8	4 – 6	********
6	7 – 9	******
13	10 –12	*************
13	13 – 15	*************
11	16 – 18	***********
6	19 – 21	******
6	22 – 24	******
3	25 – 27	***
1	28 – 30	*
2	31 – 33	**
0	34 – 36	
3	37 – 39	***
1	40 – 42	*
0	43 –45	
1	46 – 48	*
1	49 – 51	*
0	52 – 54	
2	55 – 57	**

Mean 16.78 Mode 6.38 Std.Dev 11.82

Skewness 1.52 Minimum 0.00 Maximum 56.38

Valid Cases 79 Missing Cases 0

APPENDIX A

Table 93

Histogram of Mathematics Anxiety Rating Scale 7A Undertaken by All Year 7 Female Students.

Count	Range	One Symbol For Each Occurrence
11	0 – 3	***********
12	4 – 7	************
11	8 – 11	***********
14	12 – 15	**************
13	16 – 19	*************
5	20 – 23	*****
8	24 – 27	********
5	28 – 31	*****
4	32 – 35	****
3	36 – 39	***
1	40 – 43	*
1	44 – 47	*
1	48 – 51	*
1	52 – 55	*
0	56 – 59	
0	60 – 63	
2	64 - 67	**

Mean	15.90	Mode	12.23	Std.Dev.	12.9
Skewness	1.52	Minimum	0.00	Maximum	65.30
Valid Cases	92	Missing Cases	0		

APPENDIX A

Table 94

Histogram of Mathematics Anxiety Scale 7B Undertaken by All Year 7 Female Students.

Count	Range	One Symbol For Each Occurrence.
23	0 - 3	***********************
9	4 – 6	*********
6	7 – 9	******
16	10 – 12	****************
5	13 – 15	*****
17	16 – 18	*****************
2	19 – 21	**
3	22 – 24	**
2	25 – 27	**
1	28 – 30	*
5	31 – 33	*****
0	34 – 36	
1	37 – 39	*
0	40 – 42	
0	43 – 45	
1	46 – 48	*
1	49 - 51	

Mean	11.08	Mode	0.00	Std.Dev	10.07
Skewness	1.31	Minimum	0.00	Maximum	49.40
Valid Cases	92	Missing Cases	0		

APPENDIX A

Table 95

Histogram of Mathematics Anxiety Scale 8A Undertaken by All Year 8 Female Students.

Count	Range	One Symbol For Each Occurrence.
45	0 – 5	**
		***
39	6 – 10	***************************************
25	11 – 15	*************************
15	16 – 20	***************
4	21 – 25	****
4	26 – 30	****
5	31 – 35	*****
1	36 – 40	*
4	41 – 45	****
1	46 – 50	*
1	51 – 55	*
2	56 – 60	**
0	61 – 65	
0	66 – 70	
0	71 – 75	
0	76 – 80	
0	81 – 85	
0	86 – 90	
0	91 – 95	
1	96 - 100	*

Mean	14.98	Mode	4.79	Std. Dev.	16.87
Skewness	2.97	Minimum	0.00	Maximum	100.00
Valid Cases	147	Missing Cases 0			

APPENDIX A

Table 96

Histogram of Mathematics Rating Scale 8B Undertaken by All Year 8 Female Students

Count	Range	One Symbol For Each Occurrence
42	0 - 5	**
27	6 - 9	***************************
20	10 - 13	********************
15	14 - 17	***************
8	18 - 21	********
3	22 - 25	***
8	26 - 29	********
1	30 - 33	*
4	34 - 37	****
3	38 - 41	***
5	42 - 45	*****
1	46 - 49	*
0	50 - 53	
1	54 - 57	*
0	58 - 61	
1	62 - 65	*
0	66 - 69	
0	70 - 73	
0	74 - 77	
1	78 - 81	*

Mean	13.96	Mode	4.79	Std.Dev	13.81
Skewness	1.87	Minimum	0.00	Maximum	78.72
Valid Cases	136	Missing Cases	10		

APPENDIX A

Table 97

Histogram of Mathematics Anxiety Scale 9A Undertaken by All Year 9 Female Students.

Count	Range	One Symbol For Each Occurrence.
25	0 - 5	*************************
25	6 - 9	*************************
32	10 - 13	********************************
18	14 - 17	******************
11	18 - 21	***********
7	22 - 25	*******
9	26 - 29	*********
5	30 - 33	*****
5	34 - 37	*****
4	38 - 41	****
3	42 - 45	***
1	46 - 49	*
1	50 - 53	*
2	54 - 57	**
1	58 - 61	*
1	62 - 65	*
0	66 - 69	
1	70 - 73	*
0	74 - 77	
1	78 - 81	*

Mean	16.96	Mode	3.89	Std.Dev.	14.49
Skewness	1.66	Minimum	0.00	Maximum	79.22
Valid Cases	152	Missing Cases	0		

APPENDIX A

Table 98

Histogram of Mathematics Anxiety Scale 9B Undertaken by All Year 9 Female Students.

Count	Range	One Symbol For Each Occurrence
22	0 – 4	**********************
43	5 – 9	*************************************** ****
29	10 –14	*****************************
17	15 – 19	*****************
8	20 – 24	********
10	25 – 29	**********
3	30 – 34	***
4	35 – 39	****
2	40 – 44	**
1	45 – 49	*
0	50 – 54	
2	55 – 59	**
0	60 – 64	
0	65 – 69	
0	70 – 74	
0	75 – 79	
0	80 – 84	
0	85 – 89	
1	90 - 94	*

Mean	14.24	Mode	8.8 9	Std.Dev	2.69
Skewness	2.65	Minimum	0	Maximum	93.33
Valid Cases	142	Missing Cases	3		

APPENDIX A

Table 99

Histogram of Mathematics Anxiety Scale 10A Undertaken by All Year 10 Female Students.

Count	Range	One Symbol For Each Occurrence.
18	0 – 4	******************
18	5 – 7	******************
16	8 – 10	****************
21	11 – 13	*********************
9	14 – 16	*********
9	17 – 19	*********
13	20 – 22	**************
9	23 – 25	******************
7	26 – 28	*********
4	29 – 31	****
3	32 – 34	***
4	35 – 37	****
2	38 – 40	**
1	41 – 43	*
0	44 – 46	
1	47 – 49	*
1	50 – 52	*
0	53 – 55	
1	56 – 58	*
2	59 - 61	**

Mean	16.47	Mode	6.92	Std.Dev.	12.28
Skewness	1.32	Minimum	0.00	Maximum	60.64
Valid Cases	139	Missing Cases	0		

APPENDIX A

Table 100

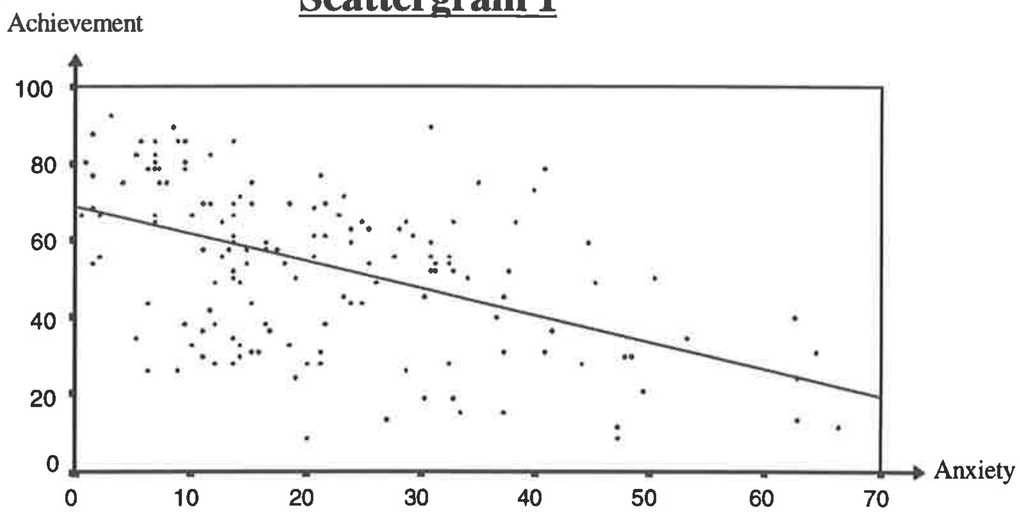
Histogram of Mathematics Anxiety Scale 10B Undertaken by All Year 10 Female Students.

Count	Range	One Symbol For Each Occurrence
9	0 – 4	*********
6	5 – 7	******
11	8 – 10	***********
5	11 – 13	*****
10	14 – 16	**********
7	17 – 19	*******
6	20 – 22	******
2	23 – 25	**
6	26 – 28	******
4	29 – 31	****
3	32 – 34	***
2	35 – 37	**
1	38 – 40	*
2	41 – 43	**
1	44 – 46	*
1	47 – 49	*
0	50 – 52	
1	53 – 55	*

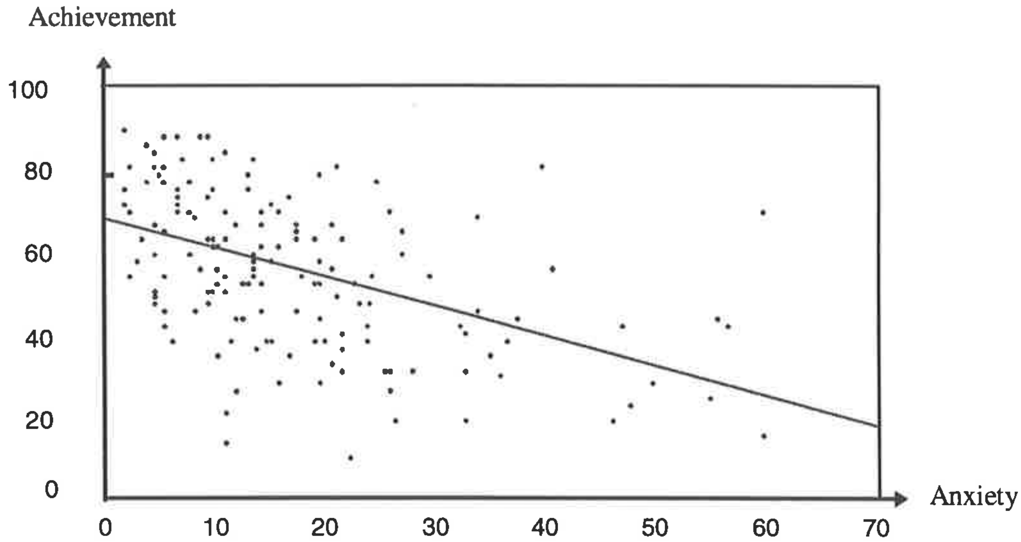
Mean	18.17	Mode	3.19	Std.Dev	12.14
Skewness	0.84	Minimum	0.53	Maximum	54.26
Valid Cases	77	Missing Cases	21		

Appendix B

Scattergram 1

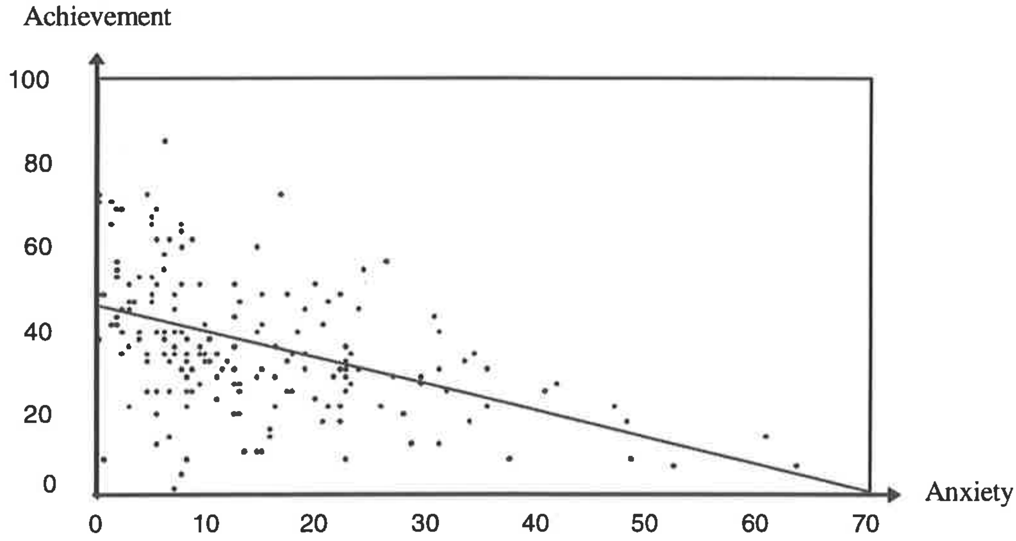


Scattergram 2

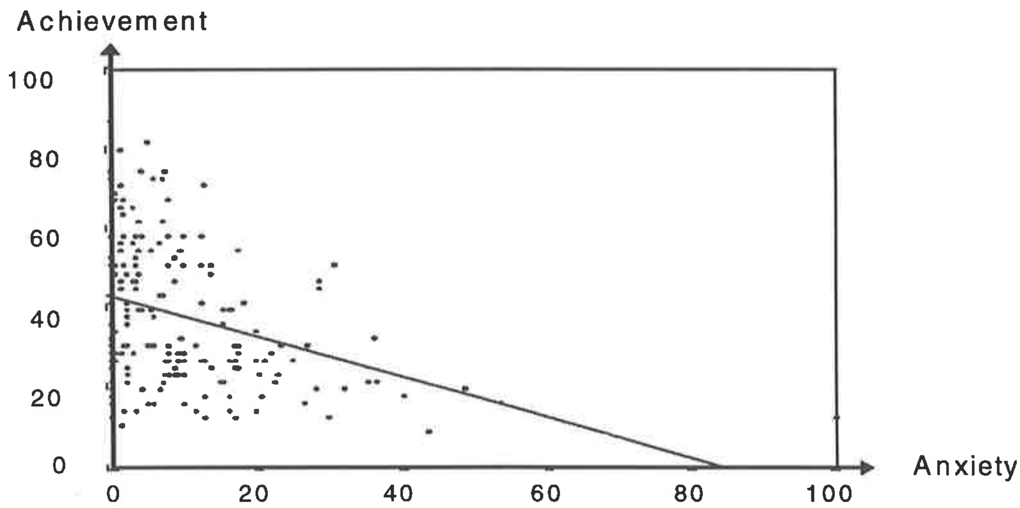


Appendix B

Scattergram 3

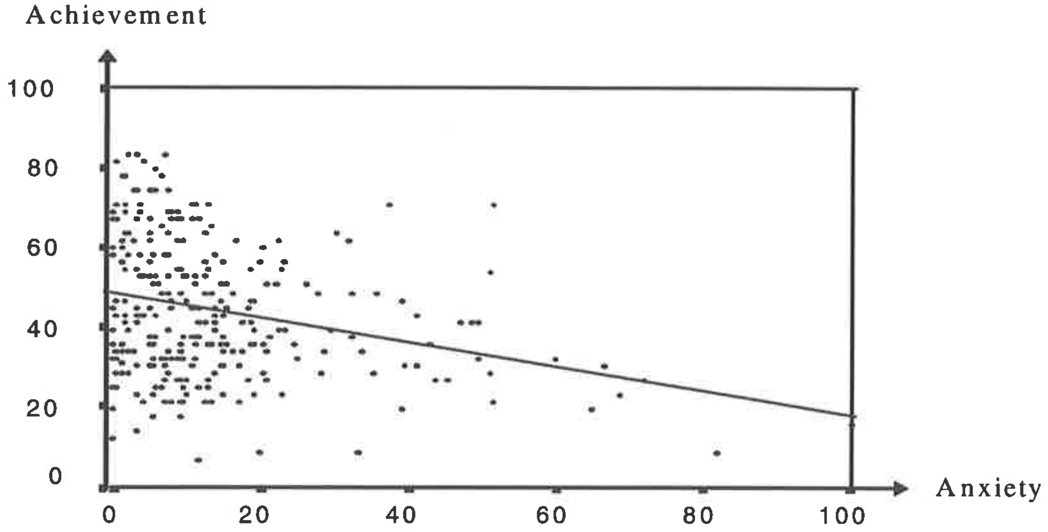


Scattergram 4

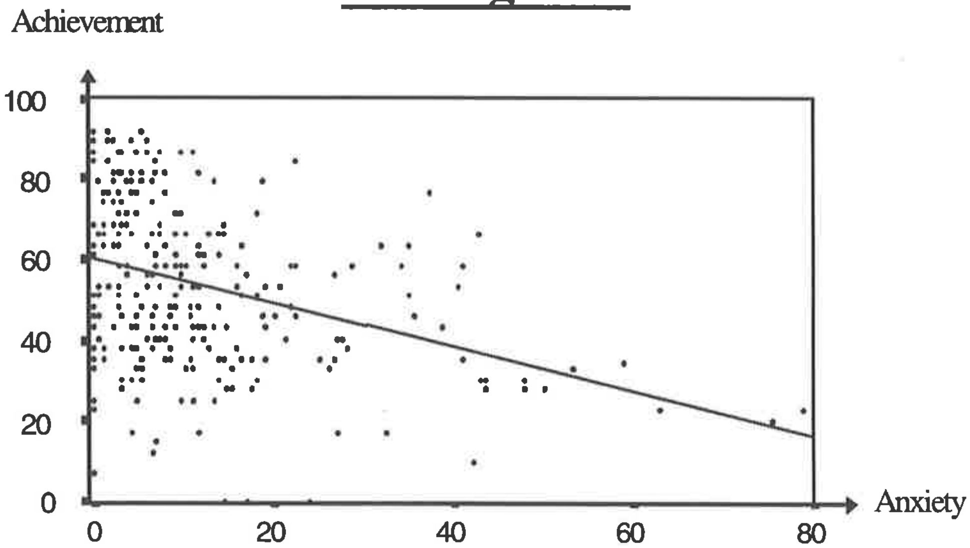


Appendix B

Scattergram 5

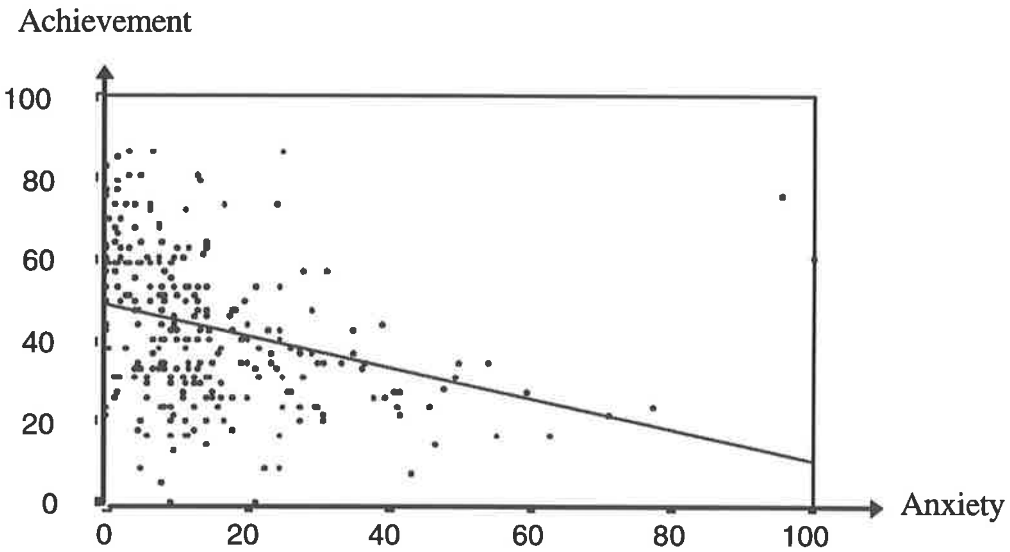


Scattergram 6

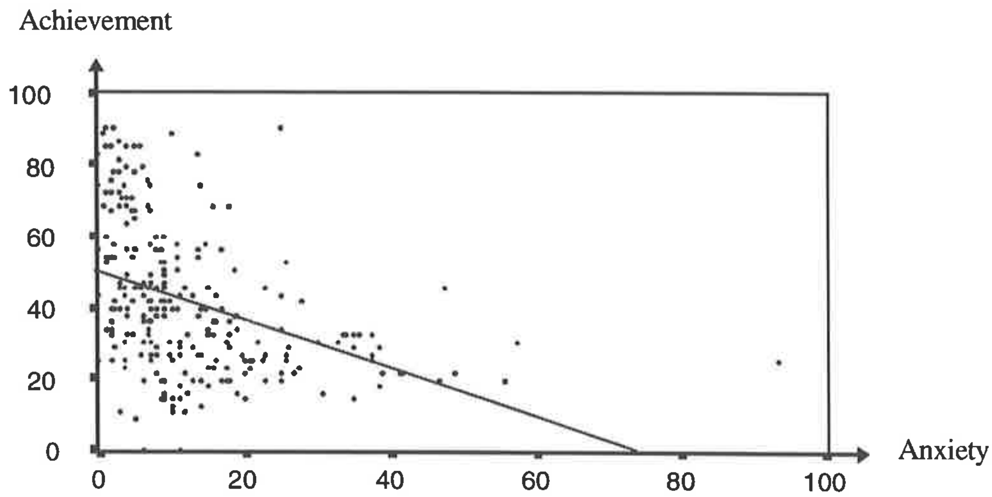


Appendix B

Scattergram 7

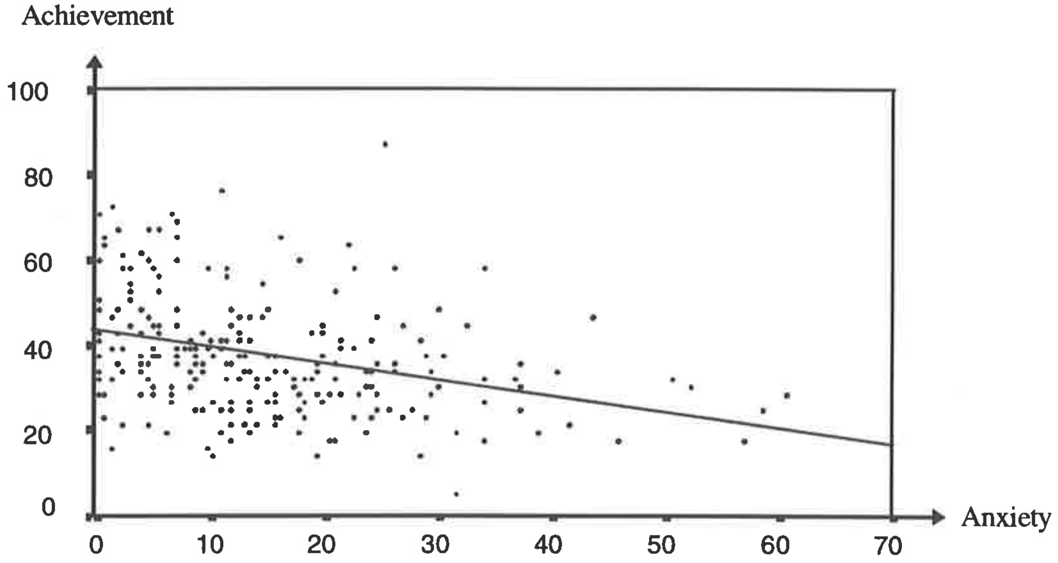


Scattergram 8

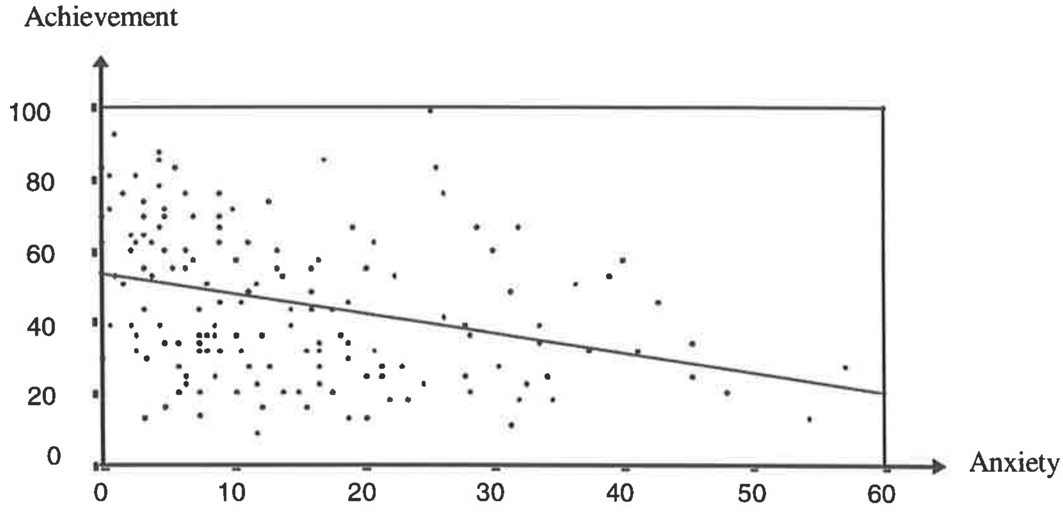


Appendix B

Scattergram 9



Scattergram 10



APPENDIX C

Mathematics

Achievement Test 8A

PATMATHS tests 6A - 7B are not included in Appendix C as these tests are published by the Australian Council for Educational Research.

With respect to the Mathematics Anxiety Scales 7A, 7B, 8A, 8B, 9A, 9B, the scales 7A and 7B, 8A and 8B, 9A and 9B were the same, but were administered with different mathematics achievement tests at two different times. The two year 10 mathematics anxiety scales were different scales.

Year 8A

Directions

This is a test of your understanding and skill in mathematics. The questions in the test are like the practice examples below. Four or five answers are given for each question. You are to choose one answer you think best.

PRACTICE QUESTIONS

P1. The number which is 2 less than 9

A 6

B 8

C 7

D 9

E 10

The best answer is 7.

You will see the number 7 has the letter C in front of it.

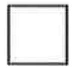
Now take your Answer Sheet to see how the answer should be filled in.

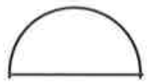
Look at the section which starts with Practice Questions . Beside P1 are the letters A,B,C,D and E . As the correct answer for P1 is C the circle under C has been filled in.

You must mark all your answers on your Answer Sheet like this.

P2 Which of these shapes is a circle:.

A. 

B. 

C. 

D None of the above

Decide which of the answers is correct, then make your answer next to P2 on the Answer Sheet.

The correct answer is D because none of the answers given in A,B,C, or D is correct. If you marked another letter, rub it out and mark the correct letter. If you want to change your answer, rub out the mark completely.

Do not mark your **Answer Sheet** in any other way.

GENERAL ADVICE.

Remember to mark only one answer for each question. Do not mark the textbook in any way.
For a number of questions you may need to do some working. Working paper has been given to you for this. Do not make any marks on the booklet. Do all your working on the working paper.

Work as quickly and as carefully as you can. Answer every question even when you are not sure of the answer, but do not spend too much time on any one question. If you cannot answer a question after thinking about it go on to the next one, but make sure that you leave a space beside that number on the answer sheet.

You have **45 Minutes** to complete the test.

DO NOT START UNTIL YOU ARE TOLD.

1. $8 + (3 \times 2) - 5$

A 8
B 18
C 9
D 17

2. $(16 + 4) \times 3 - (8 - 2)$

A 2
B 6
C 4
D 22

3. 14- - (32 ÷ 8) x 3 + (5 - 2)

A 5
B 33
C -33
D - 1

4. 28 as a product of prime factors is

A 4x7
B 2x2x7
C 28xl
D 4x6
E 2x2x3x3

5. 1536 ÷16

A 86
B 1520
C 94
D 153
E 96

6. When 211 is divided by 15 the remainder

A 1
B 6
C 16
D 61
E 196

7. $\frac{11}{36} - \frac{2}{9}$

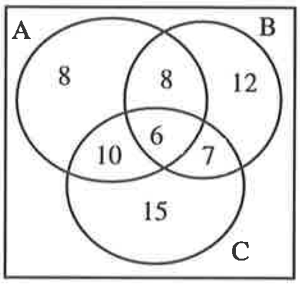
A $\frac{1}{12}$

B $\frac{9}{27}$

C $\frac{13}{45}$

D $\frac{1}{3}$

The Venn diagram below shows the numbers of elements in each of the relevant parts of the sets represented by the circles A, B and C.



Questions 8, 9 and 10 relate to the Venn diagram shown above.

8 $n(A \cap B \cap C)$

A 6
B 14
C 13
D 16
E 31

9 $n(A \cup B)$ is

A 28
B 51
C 34
D 23
E 14

10 $n(A \cup B \cup C)$ is

- A 6
- B 23
- C 31
- D 35
- E 66

11. My cat, Mr Mew, weighed $6\frac{1}{2}$ kg and was rather overweight. He was put on a diet at the cattery and lost $1\frac{3}{4}$ kg. How much did he then weigh?

- A 1 kg
- B 4 kg
- C $5\frac{1}{4}$ kg
- D $4\frac{3}{4}$ kg
- E $4\frac{1}{8}$ kg

12. \$1.05 + \$2.95 + \$1.68

- A \$5.68
- B \$6.68
- C \$5.69
- D \$4.68
- E \$4.78

13. 72 - 58.41

- A 14.41
- B 58.31
- C 130.41
- D 13.59
- E 130.59

14 The expansion of 5(4b - e) is

- A 20b - 5e
- B 20b - e
- C b - 5e
- D 20be
- E 20b + e

15. $(3\frac{1}{4})^2$

- A $9\frac{1}{16}$
- B $\frac{13}{16}$
- C $10\frac{9}{16}$
- D $6\frac{1}{2}$
- E $9\frac{1}{2}$

16. $5\times10^4\times3\times10^2$

- A 15×10^8
- B 15×10^6
- C 15×10^2
- D 15×10^{10}
- E 120×10^6

17. $\frac{128x10^{12}}{16x10^9}$

- A 8×10^3
- B $8\times10^{1.4}$
- C 8×10^{21}
- D 8×10^{-3}
- E 120×10^3

18 $\frac{x^5 \times x^4}{x^3}$

- A x^3
- B x^{12}
- C x^6
- D x^{-6}
- E $x^{\frac{20}{3}}$

19. $\sqrt{1\frac{9}{16}}$

A $1\frac{3}{4}$
B $\frac{5}{4}$
C $\frac{3}{4}$
D $\frac{5}{8}$
E $\frac{25}{4}$

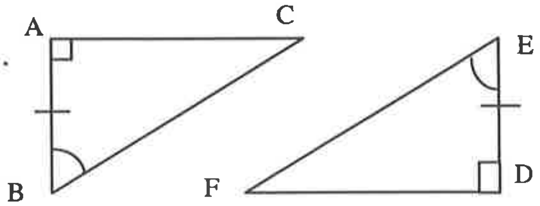
20 If $\frac{4a}{3} = 16$, then a =

A 17
B 15
C $\frac{19}{4}$
D $21\frac{1}{3}$
E 12

21. If $y \leq 12$, y cannot equal

A 11
B -5
C 0
D 12
E 13

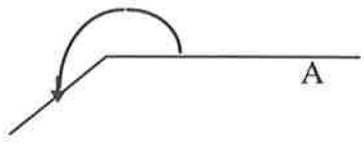
22 .



If ΔABC and ΔDEF are congruent which of the following statements are not true:

A ∠BAC = ∠EDF
B AB = ED
C ∠ACB= ∠EFD
D BC = FD
E Area of ΔABC = Area of ΔDEF

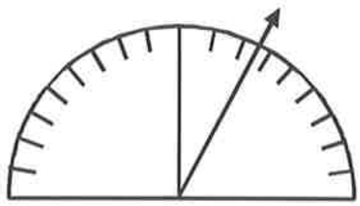
23



∠AOB is

A Acute
B Obtuse
C Reflex
D Straight
E Right.

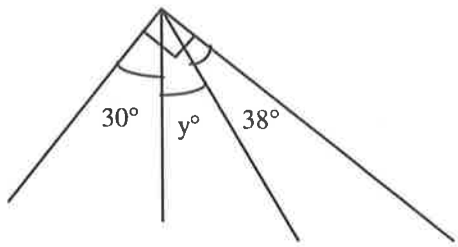
24



The size of the angle in the diagram is

A 65°
B 60°
C 70°
D 55°
E 110°

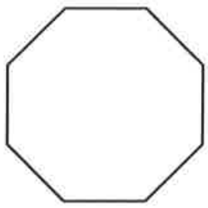
25.



The size of angle y is

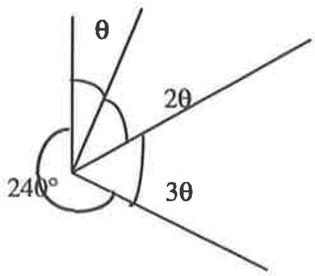
A 90°
B 68°
C 22°
D 52°
E 60°

26. The figure below is a regular



A quadrilateral
B hexagon
C pentagon
D heptagon
E octagon

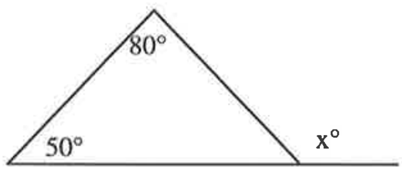
27.



The size of the angle 0 is

A 60°
B 30°
C 20°
D 120°
E 40°

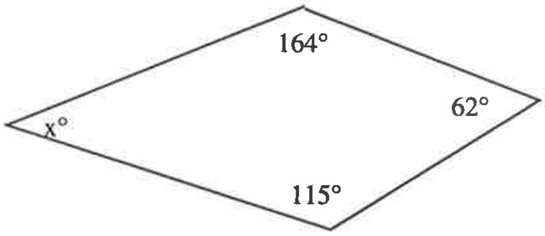
28



The exterior angle x is

A 180°
B 130°
C 80°
D 100°
E 50°

29



The fourth angle x of the quadrilateral

A 29°
B 62°
C 16°
D 19°
E 65°

30 $12\frac{1}{2}$ % in simplest form is

A $\frac{1}{8}$
B $\frac{25}{200}$
C $\frac{12\frac{1}{2}}{200}$
D $\frac{1}{4}$
E $\frac{1}{12}$

31. 0.2% in simplest form is
A $\frac{1}{5}$
B $\frac{1}{50}$
C $\frac{1}{500}$
D $\frac{2}{1000}$
E $\frac{2}{100}$

32 As a decimal 8.2% is

A 0.0082
B 0.82
C 8.2
D 0.082
E 0.00082

33. 8.4% of a class of 25 can swim. How many in the class can swim?

A 24
B 21
C 16
D 4
E 18

34 A newsagent orders 500 papers per day. Due to mechanical failure, production is reduced and therefore all newsagents receive 82.4% of their daily requirements. How many papers will this newsagent receive?

A 412
B 500
C 400
D 100
E 326

35 A real estate agent receives 4% commission on his sales. If he sells a house valued at $45,000 how much commission will he receive?

A $2000
B $11250
C $1800
D $4500
C $112.50

36 How many gm in 3.7 kg?
A 3700
B 37000
C 370
D 37
E 0.0037

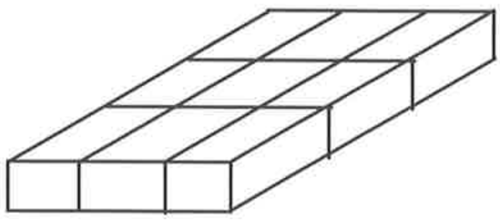
37 A yacht weighs $\frac{3}{4}$ of a tonne with its rigging. If the rigging weighs 280 kgm what is the weight of the yacht only?

A 1030 kgm
B 740 kgm
C 470 kgm
D 210 kgm
E 720 kgm

38 How far, in metres, would Sam Snail travel in 2 hours at an average speed of 0.002 km/h?

A 0.004 m
B 0.4m
C 40m
D 4m
E 0.01m

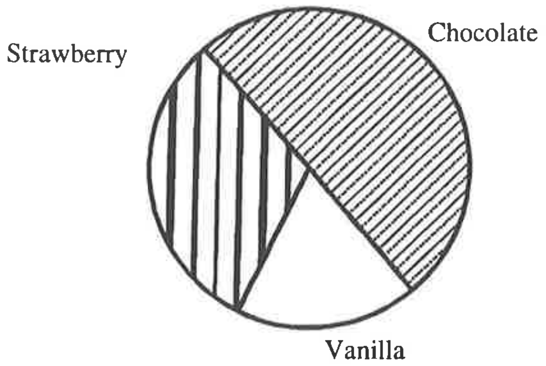
39.



A box is made up of cubes of side 1 cm. What is the volume of the box?

A 9 cm3
B 27 cm3
C 18 cm3
D 16 cm3
E 36 cm3

40



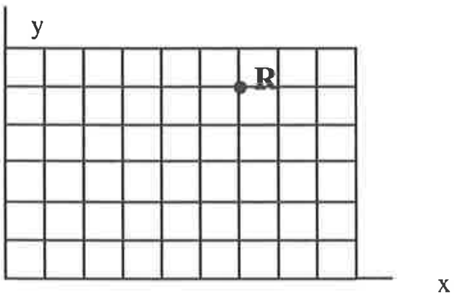
A survey of 60 children was conducted to find their favourite flavoured ice cream. Using the diagram above, which was the most popular?

A chocolate
B vanilla
C all equal
D strawberry
E none of them

41 The number of children who liked vanilla the best is

A 20
B 60
C 15
D 30
E 10

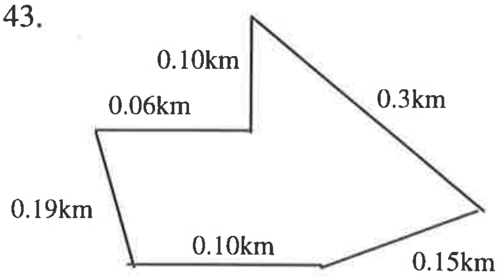
41.



On the Cartesian plane R is

A (6,5)
B (5,6)
C (6,6)
D (5,5)
E (6,0)

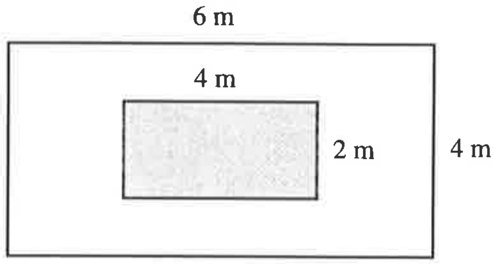
43.



The Perimeter of the field is

A 0.95 km
B 1.05 km
C 0.90 km
D 0.85 km
E 1.00 km

44.



The **non shaded** area is

A 8 m2
B 24 m2
C 16 m2
D 32 m2
E 12 m2

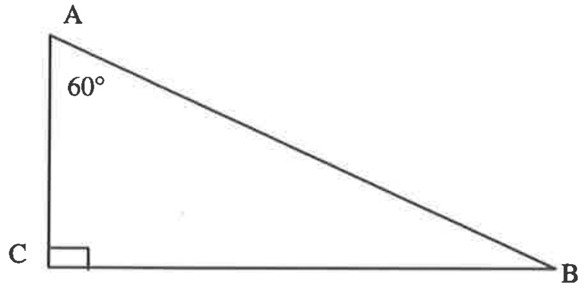
45 Rover, the faithful hound requires 5 ml of vitamins every day. The total number of litres of vitamins he would consume in a year is

A 18.25 L
B 182.5 L
C 1.825 L
D 1825 L
E 0.1825 L

46 $1^4+2^3+3^2+4^1$

A 10
B 17
C 20
D 22
E 10^{10}

47

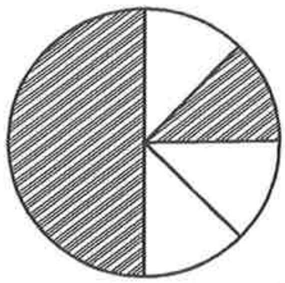


If ΔABC is right angled at C then

$\angle ABC =$

A 40°
B 130°
C 120°
D 30°
E 60°

48



The shaded area is

A $\frac{5}{8}$
B ½
C $\frac{1}{8}$
D $\frac{3}{8}$
E $\frac{5}{16}$

49. $1\frac{1}{7} - \frac{2}{5}$

A 3
B ½
C $\frac{26}{35}$
D $\frac{6}{35}$
E $\frac{6}{30}$

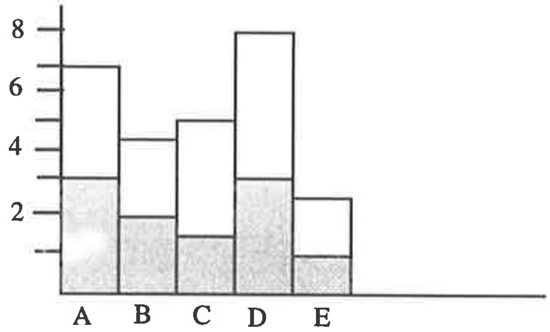
50 25^2

A 50
B 225
C 625
D 125
E 100

51 If $\frac{n}{4} = 3\frac{1}{2}$ n=

A 5
B 12
C 0.75
D 14
E 0.875

Questions 52 - 55 refer to the bar chart below



The column graph shows the amount of pocket money which Alice, Barbara, Cindy, Diana and Elsie receive each week in comparison with the amount of money they spend on tram fares.(shaded)
Questions 52, 53, 54 and 55 refer to the column graph on the previous page.

52 The total pocket money received by the girls is

A $25
B $20
C $8
D $11.50
E $27

53 The girl who spends most on tram fares is

A Alice
B Barbara
C Cindy
D Diana
E Elsie

54 The girl who has least money left after paying her fare is

A Alice
B Barbara
C Cindy
D Diana
E Elsie

55 The total fares paid by the girls is

A $13.50
B $27.00
C $12.50
D $12.00
E $14.00

APPENDIX C

Mathematics

Achievement Test 8B

Year 8

Directions

This is a test of your understanding and skill in mathematics. The questions in the test are like the practice examples below. Four or five answers are given for each question. You are to choose one answer you think best.

PRACTICE QUESTIONS

P1. The number which is 2 less than 9

A 6
B 8
C 7
D 9
E 10

The best answer is 7.

You will see the number 7 has the letter C in front of it.

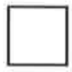
Now take your Answer Sheet to see how the answer should be filled in.

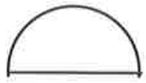
Look at the section which starts with Practice Questions . Beside P1 are the letters A,B,C,D and E . As the correct answer for P1 is C the circle under C has been filled in.

You must mark all your answers on your Answer Sheet like this.

P2 Which of these shapes is a circle:.

A. 

B 

C 

D None of the above

Decide which of the answers is correct, then make your answer next to P2 on the Answer Sheet.
The correct answer is D because none of the answers given in A,B,C, or D is correct. If you marked another letter, rub it out and mark the correct letter. If you want to change your answer, rub out the mark completely.
Do not mark your **Answer Sheet** in any other way.

GENERAL ADVICE.

Remember to mark only one answer for each question. Do not mark the textbook in any way.

For a number of questions you may need to do some working. Working paper has been given to you for this. Do not make any marks on the booklet. Do all your working on the working paper.

Work as quickly and as carefully as you can. Answer every question even when you are not sure of the answer, but do not spend too much time on any one question. If you cannot answer a question after thinking about it go on to the next one, but make sure that you leave a space beside that number on the answer sheet.

You have **45 Minutes** to complete the test.

DO NOT START UNTIL YOU ARE TOLD.

1. $2^4 + 3^3 + 4^2$

A 81
B 27
C 59
D 25

2. ((81 + 9) ÷ 3) - ((32 ÷ 4) ÷ 2)

A -1
B 11
C 23
D -13

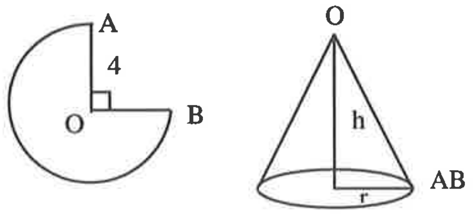
3. 25 - (40 ÷ 5 x 3) + (6 ÷ 3 ÷ 2)

A 51
B 0
C 47
D 2

4. 48 as a product of prime factors is

A 4 x 4 x 3
B 4 x 2 x 6
C 2 x 2 x 2 x 2 x 3
D 2 x 2 x 2 x 3 x 3

5 .



A circle of radius 4 cm has one quarter of its area removed as shown in the diagram. The two points A and B are joined together to form a cone of radius r cms and height h cms

5. <u>Without</u> using a calculator the radius ,r. of the cone is

A 3cm
B 4cm
C $2\sqrt{3}$ cm
D 6cm

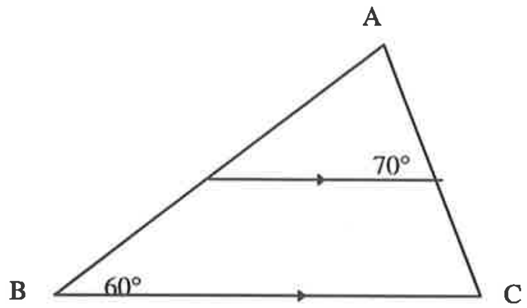
6. $\left(\frac{3}{4} \text{ x } \frac{4}{5} \div \frac{3}{5}\right) - \left(\frac{1}{3} \text{ of } \frac{3}{4} \text{ of } 4\right)$

A $\frac{3}{11}$
B 0
C $\frac{33}{52}$
D 2

7. If $\frac{3x}{5} = 6$ x is

A 2
B 30
C 10
D $3\frac{3}{5}$

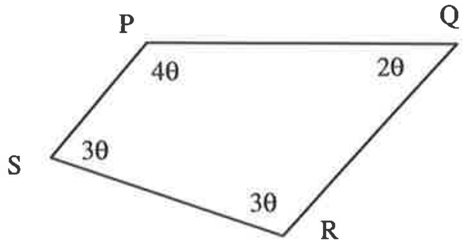
8.



The size of angle A is

A 40^0
B 50^0
C 60^0
D 120^0

9.



The size of the smallest angle is

A 60^0
B 30^0
C 90^0
D 120^0

10. As a fraction 0.125 is

A $\frac{1}{4}$

B $\frac{1}{8}$

C $\frac{1}{125}$

D $\frac{1}{12}$

11. 0.1 x 0.2 x 0.3 is

A 0.06
B 0.007
C 0.006
D 0.6

12. $16 \times 10^3 \div 8 \div 10^2$ is

A 1280
B 200000
C 24
D 20

13. If $\frac{3x}{2x10^3} = 0.003$ x is

A 18
B 2
C 2000
D 4.5

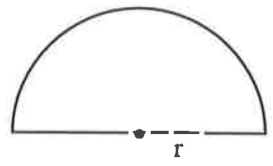
14 2.5 km is

A 2 5 m
B 2500 m
C 250 m
D 25000 m

15. $(0.25)^2$

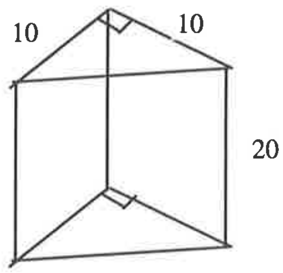
A 0.0625
B 0.625
C 0.5
D 6.25

16 The perimeter of this semicircle is



A $\pi r + 2r$
B $\frac{1}{2} \pi r^2$
C $2\pi r + 2r$
D $2\pi r + r$

17 .



The volume or this triangular prism is

A 1000 cm^3
B 2000 cm^3
C 500 cm^3
D $500 + 200\sqrt{2}$ cm^3

18. Jack bought x books at \$a each and y magazines at \$b each. If his total expenditure was \$c in Algebra the shopping bill would be

A $(x + y)(a + h) = c$
B $x + y = a + b + c$
C $ax + by = c$
D $xy + ab = c$

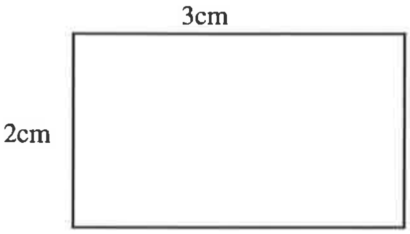
19. If $3x + 4 = 2x + 6$, then x is

A 10
B 2
C - 2
D 50

20. The number of cents in \$2a and 4b cents is

A 2004ab
B 2a + 4b
C 800ab
D 200a + 4b

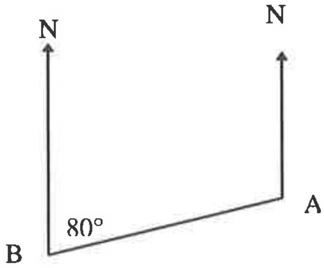
21.



The above scale diagram represents the floor of a house. If 1cm represents 2m the correct area of the floor is

A $24\ m^2$
B $6\ m^2$
C $12\ m^2$
D $60000\ m^2$

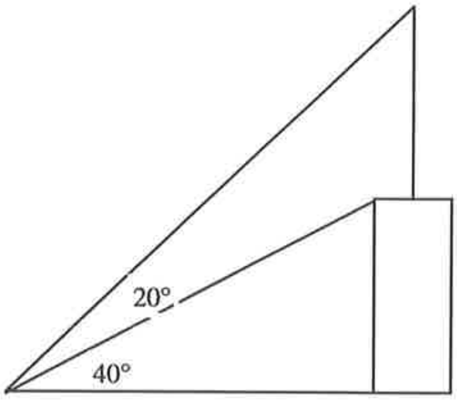
22 .



The bearing from A to B is

A 80^0
B 100^0
C 260^0
D 180^0

23.



The angle of elevation of the top of the flagpole is

A 20°
B 60
C 40°
D 30°

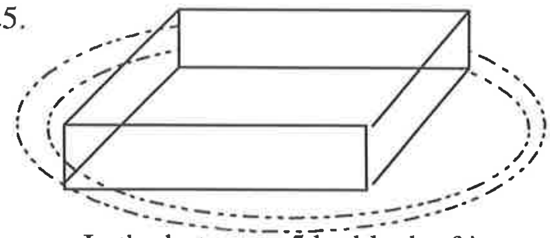
24.

1	55	3	34	5	21	7
						13
						11
						8
						13
1	?	2	19	3	17	5

The missing number is

A 3
B 9
C 21
D 23

25.



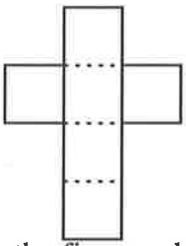
In the hot sun a 5 kg block of ice melts to 4 kg. The percentage decrease in its weight is

A 20%
B 1%
C 1kg
D 25%

26 A manufacturer of chairs estimates his total costs to be $7000 per week. If he makes 150 chairs per week and sells each chair for $80 his weekly profit will be

A $ 19000
B $ 12000
C $ 5000
D $ 6850

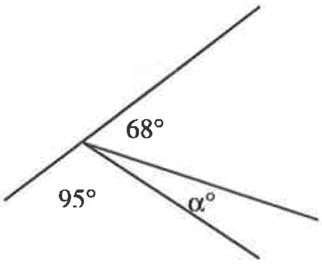
27 .



Folding the figures about the dotted lines could result in the making of a

A cube
B square
C pyramid
D cone

28



The angle labelled 'α ' is

A 85
B 22
C 27
D 17

29. Which or the following angles are supplementary?

A 52°, 38 ^{0}
B 124° , 56°
C 78°, 103°
D 30°, 60°

30. Sixty four out of eighty cars successfully completed the car rally. In simplest. form the ratio of the number of successful entrants .to total entrants is

A 5 : 4
B 4 : 5
C 64 : 80
D 80 : 64

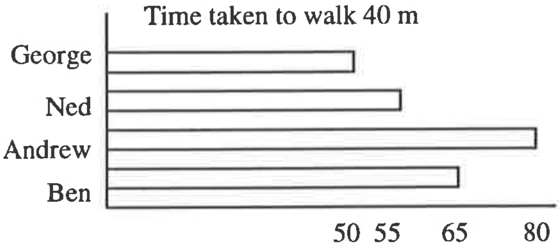
31. 19500 mm is

A 0.195 m
B 1 95 m
C 195 m
D 19 5 m

32 The number of days in 102 hours is

A 4 days
B $4\frac{1}{4}$ days
C 4 ½ days
D 8 ½ days

33.



The fastest walker was

A George
B Ned
C Andrew
D Ben

34. The slowest walker was

A George
B Ned
C Andrew
D Ben

35. The average time for the four students to walk the 40 m is

A 50 sees
B 250 sees
C 62.5 sees
D 6.5 sees

36 One method of findingthe area of A triangle is to use the formula
$A = \sqrt{s(s-a)(s-b)(s-c)}$

where $s = \frac{(a+b+c)}{2}$ and a b and c are the lengths or the sides of the triangle. Hence if ΔABC has sides of 5 cm, 12 cm and 15 cm, the area of ΔABC is

A 900 cm^2
B 30 cm^2
C 60 cm^2
D 780 cm^2

37. When 720,000 is divided by 8.000 the quotient is

A 90
B 900
C 0
D9 0 000

38. $\frac{6\times10^5}{3\times10^3}$ =

A 2×10^2
B 2×10^8
C 3×10^2
D 3×10^8

39. As an improper fraction $4\frac{3}{5}$ is

A $\frac{12}{5}$
B $\frac{19}{5}$
C $\frac{23}{5}$
D $\frac{3}{20}$

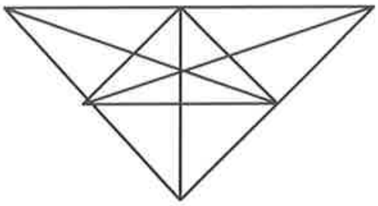
40 4 .0649 correct to 3 decimal places is

A 4 .06
B 4.065
C 4.064
D 4.07

41 As a fraction 12 ½ % is

A $\frac{25}{2}$
B $\frac{1}{6}$
C $\frac{12.5}{100}$
D $\frac{1}{8}$

42 **The number of triangles** in the figure is



A 12
B 21
C 37
D 54

43. If $6x - 3y = 18$, $y =$

A $2x - 6$
B $2x + 6$
C $6x + 18$
D $2x - 18$

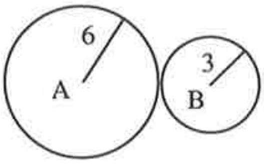
44 If $1^3 + 2^3 = 3^2$ and

$1^3 + 2^3 + 3^3 = 6^2$

Then, $1^3 + 2^3 + 3^3 + 4^3 + 5^3$

A 10^2
B 15^2
C $I20^2$
D 60^2

45 Two circles touch externally as shown



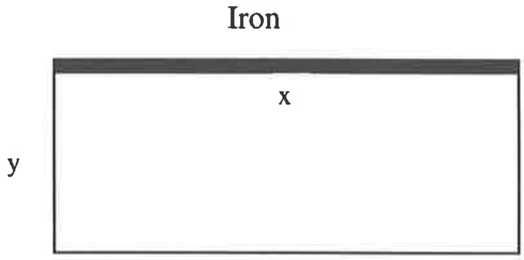
The distance AB between their centres is

A 9 cm
B 6 cm
C I2 cm
D 18 cm

46. $(x^2y^3z^4)^3 \div (x^3y^4z^6)^2$ is

A y
B $\frac{1}{z}$
C xyz
D xyz^2

47.



A rectangular block of land x m long and y m wild is to be fenced on three sides with wire and the fourth side is to have corrugated iron along it. If the cost per metre of the wire is \$18 and the cost per metre of the iron is \$30, the total cost to enclose the block is

A $60x + 36y$.
B $48x + 36y$
C $30x + 18xy$
D $2x + 2y$

48. Which of the following numbers IS NOT rational

$\{ 3, \sqrt{3}, 5.5, 3\frac{1}{3} \}$

A 3
B 5.5
C $\sqrt{3}$
D $3\frac{1}{3}$

APPENDIX C

Mathematics

Achievement Test 9A

Year 9

DIRECTIONS

This is a test of your understanding and skill in mathematics. The questions in the test are like the practice examples below. Four or five answers are given for each question. You are to choose the one answer you think is best.

Practice Questions

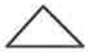
P1 The number which is 1 less than 8 is

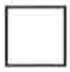
A 6
B 7
C 8
D 9
E 10

The best answer is 7 since 8 - 1 = 7. You will see that the numeral 7 has the letter B in front of it. Now take your Answer Sheet to see how the answer should be filled in. Look at the section which starts with 'Practice Questions'. Beside P1 are the letters A, B, C, D, and E. As the correct answer for P1 is B a line has been drawn in the box under B.

You must mark all your answers on your Answer Sheet like this.

P2 Which of these shapes is a circle?

A 

B 

C 

D none of these

Decide which of the answers is correct then mark your answer next to P2 on the Answer Sheet.

The correct answer is D, because none of the answers given as A, B, or C is correct. None of the shapes is a circle. If you marked another letter, rub it out and mark the correct letter. If you want to change your answer, rub out your first mark completely.

Do not mark your Answer Sheet in any other way

General Advice

Remember that you mark only one answer for each question. Do not mark the test book in any way.

For a few questions you may need to do some working. Working paper has been given to you for this. Do not make any marks on the test booklet. Do all your working on the working paper.

Work as quickly and as carefully as you can Answer every question even when you are not sure of the answer, but do not spend too much time on any one question. If you cannot answer a question after thinking about it, leave it and go on to the next one, but make sure that you leave a space beside that number on the Answer Sheet.

You will have **45 minutes** to complete the test

DO NOT START UNTIL YOU ARE TOLD

1. 405 in prime factor form is

A 9.9.5
B 9.3.3.5
C 3.3.3.3.5
D 81.5
E 27.3.5

2. If a family ate $\frac{3}{8}$ of a pie at lunch lime and $\frac{1}{4}$ of it dinner-time, the fraction left for supper time is:

A $\frac{3}{8}$
B $\frac{1}{2}$
C $\frac{1}{3}$
D $\frac{5}{8}$
E $\frac{3}{4}$

3. If x = $\frac{3}{4}$ and y = $\frac{2}{3}$ then 3x – 5y is

A 1
B $1\frac{1}{12}$
C $\frac{1}{12}$
D $1\frac{5}{12}$
E $-\frac{1}{12}$

4. $(2x)^2 + 2x^2 \_ 4x^2$

A $2x^2$
B 0
C $4x^2$
D $10x^2$
E $6x^2$

5. 25 x 14 x 4 is equal to

A 140
B 14000
C 2800
D 1400
E 1600

6. As a single fraction $\frac{2x}{3} + \frac{3x}{4}$ is.

A $\frac{5x}{7}$
B $\frac{17x}{12}$
C $\frac{5x}{12}$
D $\frac{-x}{12}$
E -x

7.If 6!= 6.5.4.3.2.1 = 720 then 8! is

A 5760
B 40320
C 5040
D 403200
E 50400

8. When simplified fully 3(x – 1) - 2(x+2) + 1 is

A x - 5
B 5x
C x
D x-4
E 6x - 6

9. As a single fraction

$\frac{x}{4} - \frac{(x-2)}{8}$ is written as

A $\frac{1}{4}$

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

C $\frac{x-2}{8}$

D $\frac{3x+2}{8}$

E $\frac{x+2}{8}$

10. When x(x+3) - 3(x+3) is simplified the answer is

A $x^2 + 6x + 9$
B $x^2 - 9$
C $x^2 - 6x - 9$
D $-2x + 9$
E $2x - 9$

The following information refers to questions 11 and 12.

11. A block of ice weighed 1.3 kg, but after being in the sun for one hour it weighed 975 gm. Its weight loss was

A 375 gm
B 275 gm
C 325 gm
D 225 gm
E 25 gm

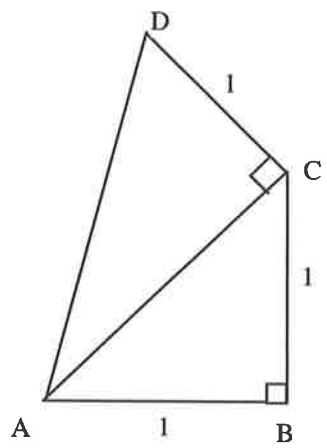
12. Its percentage weight loss was

A 29%
B 21%
C 17%
D 25%
E 2%

13. $\frac{(3x-2y)}{(6x-4y)}$ when simplified becomes

A 2
B ½
C 0
D 2x-2y
E ½x - ½y

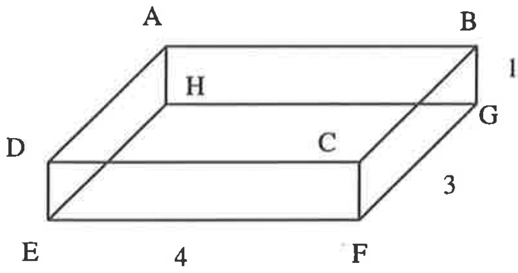
14.



ΔABC and ΔACD are right angled as shown on the diagram above. The length of side AD is

A 5
B 3
C 4
D $\sqrt{5}$
E $\sqrt{3}$

The diagram below refers to questions 15 and 16.



15. A spider is at point D on the box. It wishes to get to point G. As it can only walk along the edges of the box it must travel a minimum of

A $\sqrt{10}+4$
B 8
C $\sqrt{17}+3$
D 7
E 27

16. During the night it managed to spin a thread from point D to point G. The shortest distance the spider now travels to get from D to G is

A $\sqrt{26}$
B $3\sqrt{3}$
C 5
D 6
E 8

17. If $\frac{5}{3} = \frac{2}{x}$ then x is equal to

A 1.2
B 6
C 1
D 3.3
E 1.4

18. 500 sheets of paper are 4.8 cm thick The thickness of each sheet of paper is

A 0.096 mm
B 0.96 mm
C 0.0096 mm
D 48 mm
E 0.48 mm

19. In simplest terms, the ratio $\frac{1}{2} : \frac{3}{4}$

A 1:3
B 2:3
C 1:2
D 4:6
E 3:1

20. The interest earned in one year by investing $25000 at an interest rale of 16% per annum

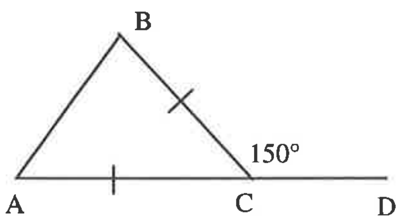
A $250
B $400
C $600
D $40 000
E $4000

21. James went birthday shopping. He bought 3 rulers at \$4.50 each, 2 pens at \$7.75 each and 4 erasers at 85c each. His total bill amounted to

A \$13.10
B \$34.00
C \$38.50
D \$32.40
E \$23.40

22 $\frac{t}{3} + \frac{t}{4} - \frac{t}{2}$

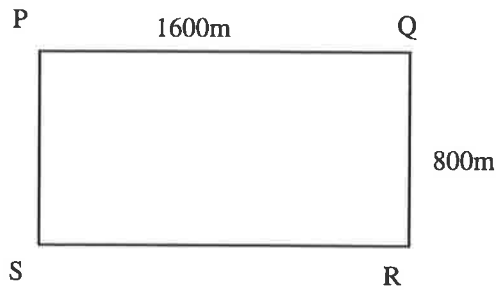
A $\frac{t}{5}$
B $\frac{3t}{5}$
C $\frac{t}{12}$
D $\frac{t}{9}$
E $\frac{3t}{2}$



23. The size of $\angle ABC$ is

A 150°
B 30°
C 75°
D 70°
E 60°

The information given in the diagram below will be required in questions 24 and 25.



PQRS is a rectangular field.

24. The Perimeter of the field is

A 2400 m
B 4800 m
C 4000 m
D 3200 m
E 1280000 m

25. The Area of the field in sq.km i s

A 1280.0 '
B 128.00
C 12.80
D 4.80
E 1.28

26 If 3-x = x+4, then x is equal to

A 0
B 7
C $-\frac{1}{2}$
D 3
E 2

27 If $\frac{3x}{2} - \frac{2x}{3} = 1$ then x is

A 1
B -1
C 6
D $1\frac{2}{5}$
E $1\frac{1}{5}$

28. If $a^3 = 27$, the a is equal to

A -3
B 9
C 3
D 81
E $\sqrt{27}$

29. 1 have three boxes.
The first box has p apples, the second box has (p-2) apples and q pears; the third box contains (p-4) apples and (q+2) pears.

The total number of apples and pears in the boxes is

A 3p + q
B 3p + q - 6
C 3p + 2q - 4
D 3p+q - 8
E 3p + q + 8

The information below refers to questions 30 and 31.

In computer language * means multiply and / means divide.

30. The answer to (2*3*4) / 8 is

A 4
B 3
C 192
D $\frac{3}{16}$
E $1\frac{1}{8}$

31. (20*8)/(20-4) is

A 4
B - 2
C $\frac{1}{2}$
D - 10
E 10

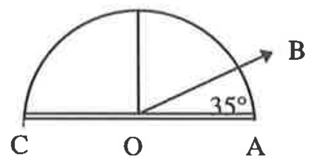
32. 14 - (32 - 8) x 3 + (5-2) is

A 5
B 33
C 90
D 23
E 39

33. 1485 is divisible by

A {2, 3, 5, 9, 11}
B {3, 5, 9, 11}
C {3, 4, 5, 9, 11}
D {5, 9, 11, 12}
E {3, 5 ,7, 9}

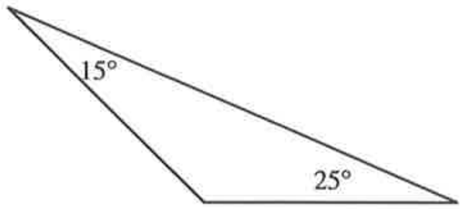
34.



The size of ∠COB is

A 550
B 145°
C 325°
D 125°
E 215°

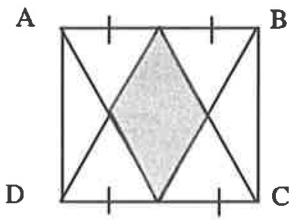
35.



The size of the third angle of the triangle is

A 40°
B 50°
C 105°
D 140°
E 115°

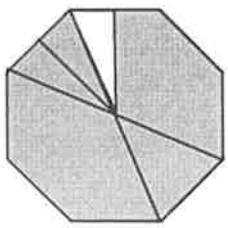
36.



ABCD is a square of side 2 cm E and F are the mid points of AB and CD respectively. The shaded area is

A $1\ cm^2$
B $2\ cm^2$
C $4\ cm^2$
D $\frac{1}{2}\ cm^2$
E $\frac{1}{4}\ cm^2$

The information in the diagram below will be required in questions 37 and 38.

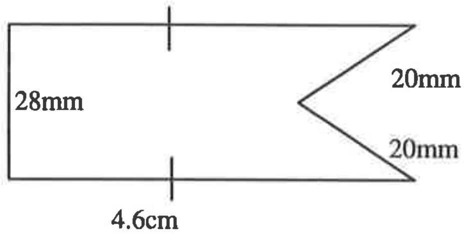


37. The <u>fraction</u> of the regular octagon which is unshaded is

A $\frac{1}{8}$
B $\frac{1}{16}$
C $\frac{1}{32}$
D $\frac{1}{4}$
E $\frac{1}{9}$

38. The <u>percentage</u> of the shape that is unshaded is

A 6.25%
B 12.5%
C 25%
D 3.12%
E 11.1%



39 The <u>perimeter</u> of the figure in <u>cm</u> is

A 72.6 cm
B 160 cm
C 114 cm
D 16 cm
E 11.4 cm

40. $2\frac{1}{4}$ tonnes expressed in kgs is

A 225 kg
B 2500 kg
C 1250 kg
D 22500 kg
E 2250 kg

41. 950 gm converts to

A 95 kg
B 9.5 kg
C 0.95 kg
D 0.095 kg
E 950000 kg

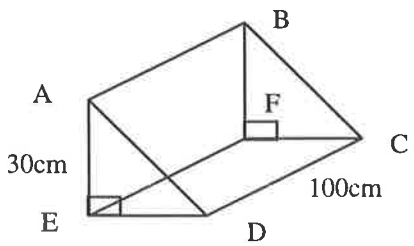
42. 5½ days is equivalent to

A 66 hours
B 132 hours
C 72 hours
D 137 hours
E 90 hours

43. A train leaves Adelaide at 7.50 p.m. on a Monday and arrives in Melbourne at 8.35 a.m. the following day. The time for the journey is

A 12 hr 45 min
B 16 hrs 25 min
C 12 hrs 25 min
D 16 hrs 45 min
E 15 hrs 35 min

The diagram refers to questions 44 and 45.



The closed triangular box is 100 cm long, 40 cm wide and 30 cm high.

44. The volume of the box is

A 120000 cm^3
B 60000 cm^3
C 3000 cm^3
D 4000 cm^3
E 12000 cm^3

45. The surface area of the box is

A 7000 cm^2
B 12000 cm^2
C 12300 cm^2
D 13200 cm^2
E 70000 cm^2

46. The reciprocal of $\frac{3}{4}$ is

A $\frac{1}{4}$
B $\frac{4}{3}$
C $-\frac{3}{4}$
D $-\frac{4}{3}$
E $\frac{1}{3}$

47. 3,6,12,24,... is a sequence.

The next 2 numbers are

A 30, 36
B 48, 94
C 48, 96
D 30, 180
E 48, 288

48. $\frac{4}{5}$ of $\frac{5}{8}$ of 0 is

A 0
B 0.5
C 1
D 6.4
E 0.8

49. If $(2\ ½)^2 = 2.3 + \frac{1}{4}$ and

$(3\ ½)^2 = 3.4 + \frac{1}{4}$ then

$(3\ ½)^2$ is

A $8.9 + \frac{1}{4}$

B $4.5 + \frac{1}{4}$

C $9.10 + \frac{1}{4}$

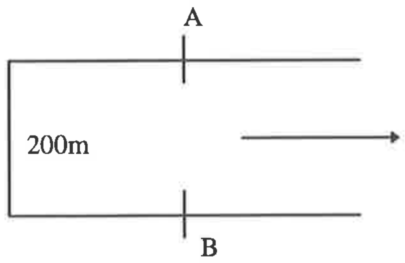
D $9.9 + \frac{1}{4}$ -

E $10.11 + \frac{1}{4}$

50. If A (2,3), B (2,-2), C (7,-2) are three of the four vertices of a rectangle, then the co-ordinates of the fourth vertex are

A (7,.3)
B (3, -2)
C (2,.7)
D (2, -2)
E (3,.7)

51.



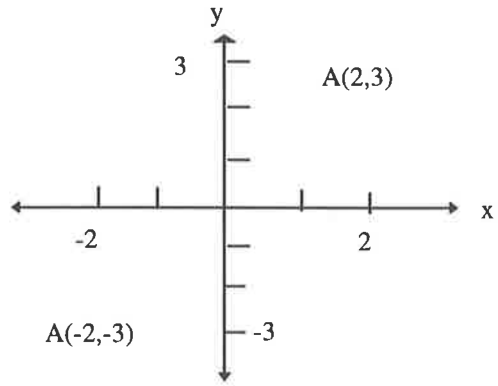
A river is 200m wide. It is flowing at a rate of 1 m per minute. An oarsman can row at the rate of 20m per minute. If he sets off from A how far to the right of B would he land if he rows at his usual rate, and the water flow remains unchanged?

A 1 m
B 200 m
C 100 m
D 40 m
E 10 m

52. a toymaker can make a box for \$6.00, a yacht for \$8.00 and a barrow for \$5.00 If he makes x boxes, y yachts and z barrows his

A 19(x + y + z)
B 19xyz
C 6x + 8y + Sz
D 240xyz
E 19

53.
A and B are two points on the co-ordinate axes as shown below:



The distance from A to B is

A $2\sqrt{13}$
B - 13
C 13
D 0
E 6

54.

2	5	9
6	9	
11		?

The numbers in the square form a pattern. The missing number in the box with the ? is

A 23
B 2
C 18
D 11
E 24

APPENDIX C

Mathematics

Achievement Test 9B

Year 9

Directions

This is a test of your understanding and skill in mathematics. The questions in the test are like the practice examples below. Five answers are given for each question. You are to choose one answer you think best.

PRACTICE QUESTIONS

P1 The number which is 2 less than 9

A 6
B 8
C 7
D 9
E 10

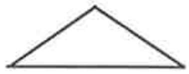
The best answer is 7. You will see the number 7 has the letter C in front of it.

Now take your Answer Sheet to see how the answer should be filled in.

Look at the section which starts with Practice Questions. Beside P1 are the letters A,B,C,D and E As the correct answer for P1 is C the circle under C has been filled in.

You must mark all your answers on your Answer Sheet like this.

P2 Which of these shapes is a circle:.

A 

B 

C 

D None of the above

Decide which of the answers is correct, then make your answer next to P2 on the Answer Sheet.

The correct answer is D because none of the answers given in A,B,C, or D is correct. If you marked another letter, rub it out and mark the correct letter. If you want to change your answer, rub out the mark completely.

Do not mark your Answer Sheet in any other way.

GENERAL ADVICE.

Remember to mark only one answer for each question. Do not mark the text book in any way.

For a number of questions you may need to do some working. Working paper has been given to you for this. Do not make any marks on the booklet. Do all your working on the working paper.

Work as quickly and as carefully as you can. Answer every question even when you are not sure of the answer, but do not spend too much time on any one question. If you cannot answer a question after thinking about it go on to the next one, but make sure that you leave a space beside that number on the answer sheet.

You have 60 Minutes to complete the test.

DO NOT START UNTIL YOU ARE TOLD.

DO NOT USE A CALCULATOR.

1. A farmer has 200 sheep. He sold 50. Soon after 90 of his flock gave birth to lambs, 30 of the 90 having twin lambs. The total number of sheep and lambs in his flock is

A 180
B 210
C 90
D 270
E 320

2. It is time for Suzie to buy books for next year. She requires 2 maths books at $11.75 each, 1 history book at $17.40 and 5 exercise books at $1.90 each. Suzie's total account comes to

A $50.40
B $31.05
C $42.80
D $38.65
E $67.80

3. John spent $\frac{3}{8}$ of his pocket money at lunch time and $\frac{1}{4}$ of it at recess. If he had $6.00 left, how much did he have to start with?

A $16.00
B $9.00
C $4.00
D $18.00
E $12.00

4. $3(2a+3b) - 2(3a-2b) =$

A $5b$
B $12a + 13b$
C $12a + 5b$
D $13b^2$
E $13b$

5. 2500 in prime factor form is

A $5^2 .10^2$
B 25.100
C $2^2.5^4$
D $25^2.4$
E $5^4.4$

6. If $a = \frac{2}{3}$ and $b = \frac{4}{5}$ then $ab + \frac{a}{b} =$

A $1\frac{21}{30}$
B $\frac{2}{3}$
C $\frac{25}{36}$
D $\frac{8}{15}$
E $1\frac{11}{30}$

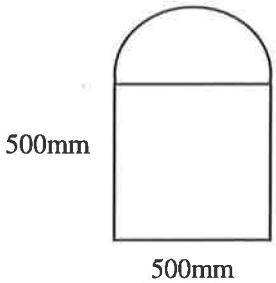
7. In a mathematics class of 35, 14 gain a credit for their work. The percentage of the class who do <u>NOT</u> gain credit is

A 60%
B 21%
C 40%
D 14%
E 49%

8 . $3(x^2 + 3x - 1) - 2(x^2 + 4x - 1) =$

A $x^2 + 17x - 3$
B $5x^2 + 17x - 3$
C $2x^3 - 1$
D $x^2 + 7x - 5$
E $x^2 + x - 1$

The following information refers to questions 9 and 10



The diagram represents a window frame. The bottom part is square, the top part is semi-circular.

9. The area of glass required to fit into the frame is

A $250000 + 250000\pi$ mm^2
B 500000π mm^2
C $250000 + 31250\pi$ mm^2
D $250000 + 62500\pi$ mm^2
E 312500π mm^2

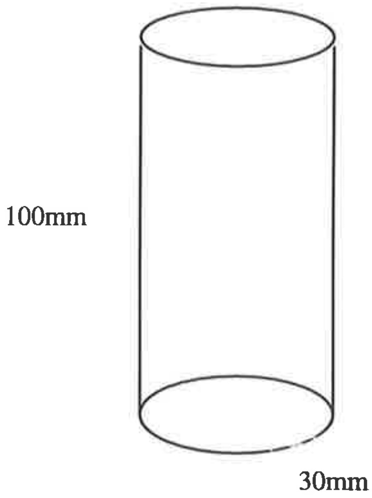
10. If the frame around the window is made out of one piece of material, its length is

A $1500 + 500\pi$ mm
B $1500 + 250\pi$ mm
C $250000 + 500\pi$ mm
D $250000 + 250\pi$ mm
E 2000π mm

11. $\dfrac{18xy}{108yx} =$

A 6
B $\frac{1}{6}$
C $6x^2y^2$
D $\frac{1}{6x^2y^2}$
E $1944x^2y^2$

The diagram below refers to questions 12, 13 and 14.



The closed cylinder has a height of 100mm and a radius of 30mm.

12. The surface area of the container

A 7500π mm^2
B 96007π mm^2
C 6000π mm^2
D 7800π mm^2
E 6900π mm^2

13. The volume of the container is

A 9000π mm^3
B 900000π mm^3
C $90000r\pi$ mm^3
D 6000π mm^3
E 12000π mm^3

14 If the radius of the cylinder was doubled its new volume would be

A 12000π mm^3
B 36000π mm^3
C 240000π m^3
D 360000π mm^3
E 720000π mm^3

15. How many $5.60 books can I buy for $112.00

A 200
B 2
C 22
D 56
E 20

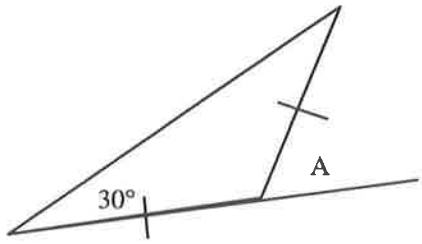
16. If P : Q : R = 5 : 6 : 7, find R if P = 35

A 42
B 49
C 35
D 37
E 210

17. If $\frac{2x-1}{3} = 13$, then x=

A 20
B 38
C 19
D 6
E 18

18.



The size of angle A is

A 150°
B 120°
C 30°
D 60°
E 200°

The following information refers to questions 19 and 20.

With the withdrawal from circulation of all 1c and 2C, a litre of milk which costs $1.02 is rounded down to $1.00 if only one litre is purchased. If two cartons are purchased the amount owing, $2.04, is rounded up to $2.05.

19. If a householder bought 1 carton of milk each day and paid the milkman once a fortnight, the amount to be paid would be

A $14.30
B $14.00
C $7.15
D $14.38
E $14.40

20. If the same householder paid the milkman every night, the amount saved over the fortnight would be

A $14.00
B 15^c
C 20^c
D 35^c
E 30^c

21. If $(2\frac{1}{2})^2 = 2 \times 3 + \frac{1}{4}$

If $(3\frac{1}{2})^2 = 3 \times 4 + \frac{1}{4}$

and $(4\frac{1}{2})^2 = 4 \times 5 + \frac{1}{4}$

then $(11\frac{1}{2})^2 =$

A $11 \times 12 + \frac{1}{2}$
B $10 \times 11 + \frac{1}{2}$
C $12 \times 13 + \frac{1}{2}$
D $10 \times 12 + \frac{1}{2}$
E $11 \times 12 + \frac{1}{4}$

22. $\frac{t}{2} + \frac{t}{3} = \frac{p}{10}$

P in terms of t =

A $\frac{t}{2}$
B $\frac{25t}{3}$
C $\frac{t}{5}$
D 4t
E $\frac{8t}{3}$

23. If $5 - 2x = 3x + 9$, then x =

A - 4
B 14
C - 0.8
D 2
E 0.8

This information refers to questions 24 and 25.

Before the introduction of the calculator, π was approximated to $3\frac{1}{7}$.

24. Using this value of π, the area of a circle of radius 7 cm is

A 44 cm^2
B 21 cm^2
C 154 cm^2
D 14 cm^2
E 147 cm^2

25. If the radius is increased to 14 cm, the area of the larger circle is

A 616 cm^2
B 88 cm^2
C 308 cm^2
D 28 cm^2
E 194 cm^2

26. In computer language * means multiply, / means divide and ^ means to the power of.

Thus (2 * 3) ^ 2 is

A 18
B 3
C 12
D 36
E 9

27. 24 / 6 * (2 ^ 3) =

A 6
B 512
C 32
D 8
E 0.5

28. B is 3km from A on a bearing of 60° T. The bearing and distance of A from B is

A 120° T, 6 km
B 120° T, 3km
C 240° T, 6km
D 240° T, 3km
E 300° T, 3km

29 The number of mm in 2.25km is

A 2250 mm
B 2250000 mm
C 225000 mm
D 0.0225 mm
E 22.5 mm

30. Light travels at 300 million metres per second. The distance travelled by light in one minute is

A 18000 m
B 5000000 m
C 108000000 m
D 18000000000 m
E 108000000000 m

31. Our nearest star, Alpha Centura, 3 light years away from earth. If a spaceship could travel at ½ the speed of light, the return journey would take

A 3 years
B 6 years
C 12 years
D 24 years
E 2.5 years

32. If $x = 3\frac{3}{4}$ then $\frac{1}{x}$ is

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

B $\frac{4}{15}$

C $\frac{4}{9}$

D $\frac{5}{3}$

E $\frac{4}{3}$

33. $1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}$ is a series.

The next term in tis series is

A $\frac{1}{16}$

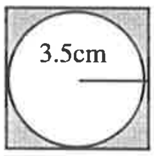
B $\frac{1}{12}$

C $\frac{7}{8}$

D $\frac{1}{32}$

E $\frac{1}{64}$

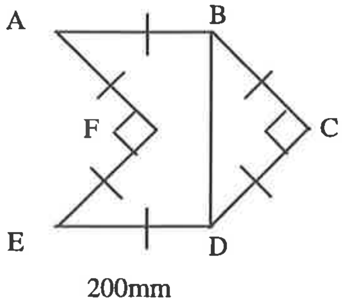
34.



The circle touches the sides of the square. If the radius of the circle is 3.5 cm, the shaded area is

A $38.5\ cm^2$
B $87.5\ cm^2$
C $49\ cm^2$
D $10.5\ cm^2$
E $27\ cm^2$

35.



The perimeter of the regular figure, ABCDEF is

A 1400 mm
B 600 mm
C 1200 mm
D 40000 mm
E 1000 mm

36. The Area of ΔBCD is

A 40000 mm^2
B 80000 mm^2
C 2000 mm^2
D 4000 mm^2
E 20000 mm^2

37. The year 2001 will be in the

A 20^{th} century
B 22^{nd} century
C 19^2 century
D 21^{st} century
E none of these

38. If $\frac{x+2}{3}$ - $\frac{2x-1}{4}$ = $\frac{5}{12}$, then x =

A - 3
B - 4
C 3
D 0
E 1

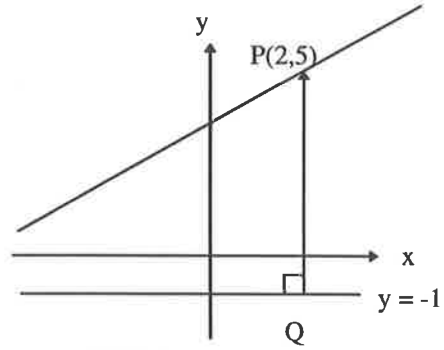
39. Consider P = $\frac{n+1}{n-1}$ where n is any whole number (integer). (The equation is used in questions 39 and 40.)

The value of P when n = -3 is

A 2
B ½
C - 1
D - ½
E 1

40 P = O when n =
A - 1
B O
C 1
D 1000
E 1000000

41.



The distance of PQ is

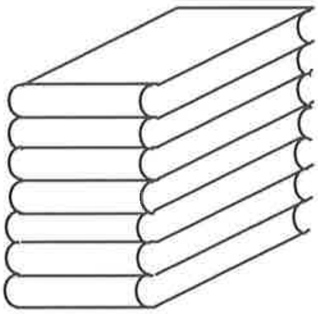
A 5
B 4
C 7
D 6
E - 6

42. 26 + 25 x 4 – 112 – 7 =

A 85
B 99
C 7
D 11
E - 2681

43. $[(2x)^3 + 3x^3] - x^3$ is

A 5
B 11
C 10
D $10x^3$
E $8x^3$



The diagram represents 7 volumes of mathematics. Each book is 20 cm wide 30 cm long and 3 cm thick.

44. The volume of the books stacked as in the diagram is

A 12600 cm^3
B 1800 cm^3
C 4200 cm^3
D 710 cm^3
E 361 cm^3

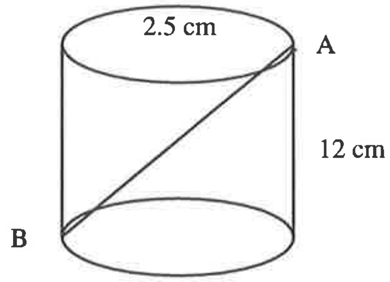
45. If the books were laid out side the area covered by the books would be

A 12600 cm^2
B 420 cm^2
C 630 cm^2
D 4200 cm^2
E 1800 cm^2

46. $I = \frac{PTR}{100}$ and P = $15000, T = 3 years, and R = 8%, I is

A .$360 00
B $3600
C $150.11
D $360
E $151.10

47.

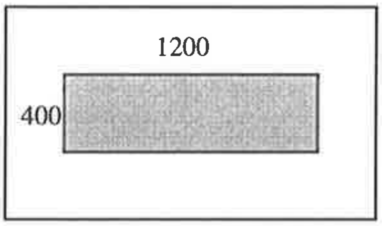


A cylindrical container is 12 cm high with a radius of 2.5 cm.

The shortest distance from A to B inside the container is

A 17 cm
B 12 cm
C 14.5 cm
D 13 cm
E 19.1 cm

48.



A modern painting is 1 200mm wide and 400mm high. It was decided to frame the painting, allowing for a 300mm border all round.
The total length of the frame would be

A 2800 mm
B 5000 mm
C 4400 mm
D 1800 mm
E 600 mm

49. The total area of glass required to frame the painting is

A 1800000 mm^2
B 480000 mm^2
C 1050000 mm^2
D 1260000 mm^2
E 1500000 mm^2

50. What percentage of \$50 is \$2.50?

A 50%
B 95%
C 2.5%
D 5%
E 25%

51 The number of 5^C pieces in \$5.50 is

A 275
B 55
C 110
D 550
E 11

52.

x	-1	0	1	2
3x	-3	0	3	6
6	6	6	6	6
y	3	6	9	12

From the table, the relationship between x and y is

A $y = 3x$
B $y = x + 6$
C $y = 6 - 3x$
D $y = 3x + 6$
E $y = 3(x+ 6)$

53.

$3x(x + y) + 2y(x - y) - 2(x^2 - xy + y^2) =$

A $x^2 + 3xy$
B $x^2 + 7xy - 4y^2$
C $x + 3xy$
D $3x^2y + 2xy^2 - 2x^3y^3$
E $x^2 + 3xy - 4y^2$

54 $\frac{3x}{4} + \frac{2x}{3} - \frac{5x}{6} =$

A $\frac{10x}{13}$
B $\frac{7x}{12}$
C $\frac{x}{6}$
D 0
E $\frac{27x}{2}$

55 If 8! = 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1 = 40320 then $\frac{9!}{7!} =$

A 9
B $\frac{72}{7}$
C 504
D 72
E $\frac{1}{72}$

APPENDIX C

Mathematics

Achievement Test 10A

Year 10

Directions

This is a test of your understanding and skill in mathematics. The questions in the test are like the practice examples below. Five answers are given for each question. You are to chooseone answer you think best.

PRACTICE QUESTIONS

P1 The number which is 2 less than 9

A 6
B 8
C 7
D 9
C 10

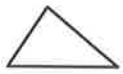
The best answer is 7. You will see the number 7 has the letter C in front of it

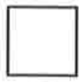
Now take your Answer Sheet to see how the answer should be filled in.

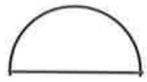
Look at the section which starts with Practice Questions. Beside P1 are the letters A,B,C,D and E . As the correct answer for P1 is C the circle under C has been filled in.

You must mark all your answers on your Answer Sheet like this.

P2 Which of these shapes is a circle:.

A 

B 

C 

D None of the above

Decide which of the answers is correct, then make your answer next to P2 on the Answer Sheet

The correct answer is D because none of the answers given in A,B,C, or D is correct. If you marked another letter, rub it out and mark the correct letter. If you want to change your answer, rub out the mark completely.

Do not mark your Answer Sheet in any other way

GENERAL ADVICE.

Remember to mark only one answer for each question. Do not mark the text book in any way.

For a number of questions you may need to do some working. Working paper has been given to you for this. Do not make any marks on the booklet. Do all your working on the working paper.

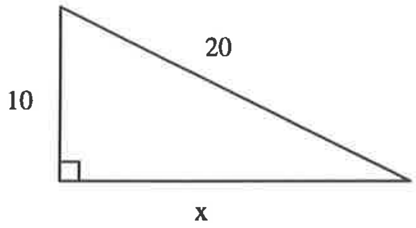
Work as quickly and as carefully as you can. Answer every question even when you are not sure of the answer. but do not spend too much time on any one question. If you cannot answer a question after thinking about it go on to the next one, but make sure that you leave a space beside the number on the answer sheet.

You have 60 Minutes to complete the test.

DO NOT START UNTIL YOU ARE TOLD.

DO NOT USE A CALCULATOR.

1.



The size of the side, x is

A 20
B 15
C $\sqrt{3}$
D $10\sqrt{3}$
E $20\sqrt{3}$

2. A(3, 7) and B(-5, 2) are two points on a line. The slope of the line is

A $\frac{8}{5}$
B $\frac{5}{8}$
C $-\frac{5}{8}$
D $-\frac{3}{8}$
E $\frac{7}{4}$

3. When simplified $8\frac{3}{5}$ is

A 8.6
B 8 3
C 43
D 40..3
E 23

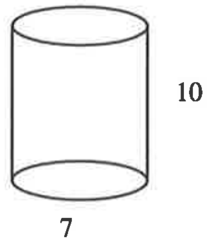
4. If $x + y = 9$

And $2x - 3y = 3$

X and y are equal to

A (6, 3)
B (6, -3)
C (-6, 3)
D (3, 6)
E (-6, -3)

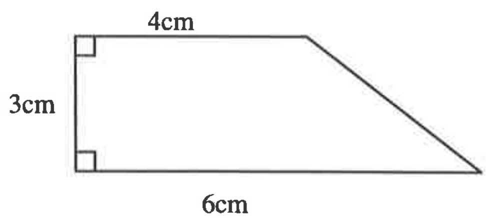
5.



The cylinder has a diameter of 7 cm and a height of 10 cm. Its volume is

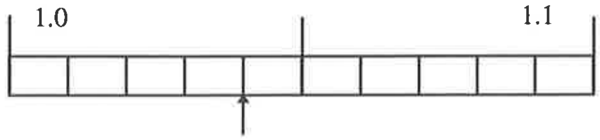
A $\frac{245\pi}{2}$
B 245π
C 490π
D $\frac{290\pi}{2}$
E 70π

6. The perimeter of the following diagram is



A 26 cm
B $13 + \sqrt{13}$
C $10 + \sqrt{13}$
D $14 + \sqrt{13}$
E 17

7.



The position on the scale indicated by the arrow is

A 1.004
B 1.04
C 1.08
D 1.4
E 1.05

8. Emma collected 50 cent and 20 cent coins in a money box. When the box was opened, she found 87 coins with a total value of \$27.00 . The number of 50^c coins in the box was

A 32
B 55
C 87
D 96
E 17

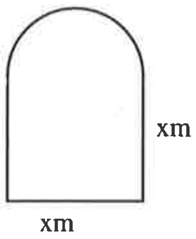
9. A restaurant uses square tables with sides 1.5m and round table cloths of diameter 2.4 m The percentage of table cloth hanging over the edge of the table is approximately equal to

A 25%
B 30%
C 40%
D 60%
E 50%

10. 3 km + 54 m + 18 cm

A 3·05418 m
B 354·18 m
C 3054·18 m
D 35418 m
E 35·418 m

The diagram refers to questions 11 and 1 2.



The diagram illustrates a door in which the bottom section is a square of side x m, and the top section is semicircular.
The perimeter of the door is 10 m.

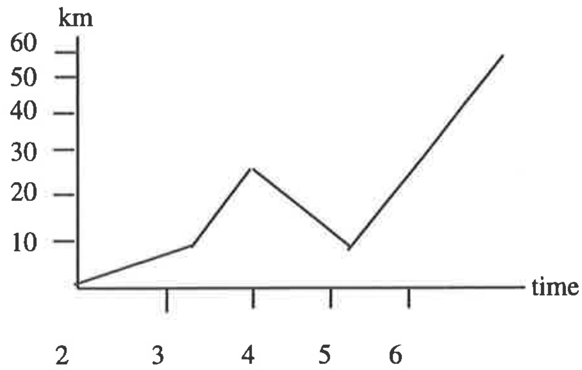
11. The width, x, of the door is

A $\frac{20}{6 + \pi}$
B $\frac{20}{3 + \pi}$
C $\frac{10}{6 + \pi}$
D $\frac{10}{3 + \pi}$
E $\frac{80}{24 + x\pi}$

12. The area of the door is

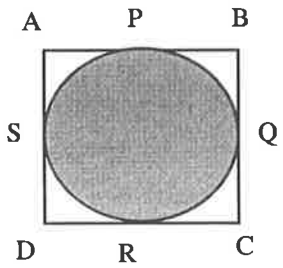
A $x^2 + \pi x^2$
B $x^2 + \frac{\pi x^2}{2}$
C $4x^2 + \frac{\pi x^2}{2}$
D $x^2 + \frac{\pi x^2}{8}$
E $x^2 - \frac{\pi x^2}{8}$

13 The graph illustrates a cyclist's trip from Adelaide to a town 60 km away. At one stage the cyclist had to turn back because he had discovered he had lost something. This probably happened at



A 4.00 pm
B 4.30 pm
C 5.00 pm
D 5.30 pm
E 3.00 pm

14.



ABCD is a square of side x cm. P,Q,R and S are the mid points of the side of the square. A circle is inscribed within the square as illustrated.
The area of the unshaded region is equal to

A $x^2 - \pi x^2$
B $x^2 - \frac{1}{2}\pi x^2$
C $x^2 - \frac{1}{4}\pi x^2$
D $x - \frac{1}{8}\pi x^2$
E $x^2 - \frac{1}{16}\pi x^2$

15 Four cuboids (rectangular boxes) have dimensions (incms) as follows

P $1\times4\times6$
Q $2\times4\times5$
R $2\times3\times6$
S $3\times4\times4$

If the cuboids are arranged in order of increasing volume, the order is

A P,Q,R,S
B Q,R,S P
C P,R,Q,S
D R,P,Q,S
E Q,S,P,R.

16. $[(-3)^2 + (-2)^3] + (-1) =$

A 17
B -17
C 1
D -1
E 0

17. $\sqrt{(9+16)} =$

A 25
B 5
C 7
D 12
E 12.5

18. $3\sqrt{-27} =$

A -3
B 9
C -9
D 3
E $\frac{-1}{3}$

19. (-x).(x)

A x^2
B $-2x$
C $-x^2$
D $(-x)^2$
E $-\sqrt{x}$

20 The formula for the total surface area of a rectangular box is given by

$$S = 2x^2 + 4xh$$

If h is to be determined which of the following is correct?

A $h = \frac{(S + 2x^2)}{4x}$

B $h = \frac{S - x}{2}$

C $h = \frac{S + x}{2}$

D $h = \frac{(S - 2x^2)}{4x}$

E $h = S - 2x^2 - 4x$

21. For all n and k,
$(22n - k) - (n - k) =$

A 21n - 2k
B 23n -2k
C 22 -2k
D 21n
E 23n

22. Which one of the following series of operations on the expression
$$\frac{3x - y + 4}{5}$$
will lead to an answer of 3x equals

A Multiply by 5, add 4, add y
B Divide by 5, subtract 4, add y
C Multiply by 5,add y, subtract 4
D Subtract 4, add y, multiply by 5
E Divide by 5, add 4, subtract y

23. $\frac{x}{3} + 1 = 6$, then x is equal to

A 3
B 15
C 17
D 21
E 19

24. The length of a rectangular lawn is 4 m greater than its breadth. If the breadth is x cm and the area is 192m2, an equation which may be used to find the breadth of the lawn is

A $2x + 4 = 192$
B $4x + 8 = 192$
C $4x^2 = 192$
D $x^2 + 4x = 192$
E $x^2 - 4x = 192$

25. Which of the following ordered pairs (x, y) satisfies $x^2 + y^2 > 16$

A (0 , 0)
B (0 ,- 4)
C (2 , 2)
D (- 3 , 3)
E (4 , 0)

26. The solution to the simultaneous equations
x - 2y = 3
2x + y = 11 is

A x = 7, y = 2
B x = 4, y =3
C x = - 1, y = - 2
D x = 5, y = 1
E x =3, y = 3.

27. The graphs representing

5x + 2y = 10 and
10x + 4y = 20 have

A no points in common
B one point in common
C two points in common
D three points in common
E more than 3 points in common

28. $p^2 - 5p + 6$ factorizes into

A $(p-1)(p-6)$
B $(p+3)(p-2)$
C $(p-2)(p-3)$
D $(p+2)(p+2)$
E $(p+1)(p-6)$

29. When simplified
$\frac{1}{4}(x-8) - \frac{3}{4}(7x-4)$ is equal to

A - 5x + 1
B - 5x + 5
C - 20x + 1
D - 22x - 5
E $\frac{11}{2}x - \frac{29}{16}$

30. If 2x + 8y = 10 then x is equal

A 5 – 4y
B 5 – 8y
C 10 – 4y
D 10 + 8y
E 5 + 8y

31. a(a+2b) + b(a+2b) equals

A $a^2 + 3ab + 2b^2$
B $a^2 + 3ab + 4b^2$
C $a^2 + 2ab + 2b^2$
D $a^2 + ab + 4b^2$
E 2a + 3ab + 4b

32 For all real x, x^4- 16 equals

A $(x - 2)^4$
B $(x-2)^2(2+2)^2$
C $x^2(x-4)(x+4)$
D $(x-2)(x+2)(x^2+4)$
E $(x-2)(x-2)(x+2)(x+2)$

33. The area of an Equilateral triangle of side 10cm is

A $50\sqrt{3}$
B $25\sqrt{3}$
C 50
D $5\sqrt{3}$
E $33\frac{1}{3}$

34. The Volume of a sphere is $\frac{4}{3}\pi r^3$

A hemispherical bowl of radius 5 cm is full of sand. This sand is carefully poured into a sphere. If the sphere is completely filled by the sand its radius is

A 5
B $\frac{\sqrt{125}}{2}$
C $\frac{125}{2}$
D $\frac{5}{2}$
E $\frac{5}{3\sqrt{2}}$

35 . (p - 1)(p + 6) is equal to

A $p^2 - 6p + 6$
B $p^2 - 5p - 6$
C $p^2 - 7p - 6$
D $p^2 + 5p - 6$
E 2p - 6

36 For all real numbers a and b, a - b equals

A $\frac{a^2 - b^2}{a - b}$
B $(\sqrt{a} - \sqrt{b})^2$
C $(\sqrt{a} - \sqrt{b})(\sqrt{a} + \sqrt{b})$
D $\frac{(a^2 + b^2)}{a + b}$
E $\frac{(a+b)^2}{a-b}$

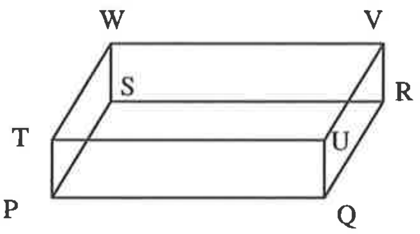
37 There are 100 tickets in a raffle. Fred buys, 3 tickets. The probability of Fred winning <u>first</u> prize is.

A 3
B 0.3
C 0.03
D 0.003
E 33.3

38. If x = 3 and y = 1 the value of $x^2 + y^2$ is

A 16
B 10
C 8
D 5
E 4

39.



PQRSTUVW is a Cuboid. The angle between planes PUVS and WVUT is equal to angle

A $\angle$PVW
B $\angle$PVT
C $\angle$PVU
D $\angle$PUW
E $\angle$PUT

40. If $x * y = \frac{x}{y} - xy, y \neq 0$, then 2 * 4 equals

A $-7\frac{1}{2}$
B - 6
C 6
D $7\frac{1}{2}$
E $8\frac{1}{2}$

41 A cubic box has <u>NO</u> lid. If its sides are 20 cm long, its inner Surface Area is

A 400 cm^2
B 200 cm^2
C 2000 cm^2
D 45 cm^2
E 40000 cm^2

42. If $V = \pi r^2 h$ then h is equal to

A $V\pi r^2$
B $V - \pi r^2$
C $\frac{V}{\pi r^2}$
D $\frac{\pi r^2}{V}$
E $\sqrt{\frac{V}{\pi r}}$

43. If $32 \times 32 \times y = 64^3$ then y equals

A 16
B 32
C 64
D 256
E 1024

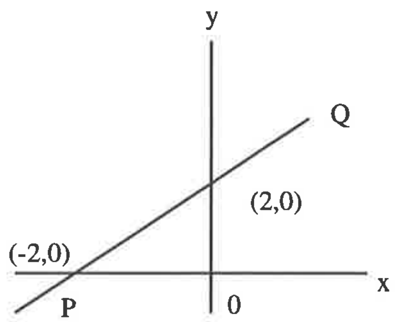
44. If px + q = r then x equals

A $\frac{r - q}{p}$
B $\frac{q - r}{p}$
C $\frac{r}{p} - q$
D $\frac{r}{p + q}$
E $r - p - q$

45. If $p = \frac{\sqrt{3}}{2}$ and $q = \frac{2}{\sqrt{3}}$ then $p^2 + pq + q^2$ is equal to

A $2\frac{31}{36} + \sqrt{6}$
B $3\frac{1}{12}$
C 9
D $\frac{7}{\sqrt{3}}$
E $5 + 2\sqrt{3}$

46.



The equation of PQ is

A $y = 2x + 2$
B $y = 2x - 2$
C $y = x + 2$
D $y = -x + 2$
E $y = x - 2$

47. If $\frac{a}{b} = \frac{3}{4}$ and $\frac{b}{c} = \frac{8}{9}$ then $\frac{a}{c} =$

A $\frac{2}{3}$
B $\frac{3}{2}$
C $\frac{1}{6}$
D 6
E $\frac{27}{32}$

48. If $14 - 5x \geq 9$ then x is

A 1
B - 1
C ≥ 1
D ≥ -1
E ≤ 1

49. For all non zero x, y and z

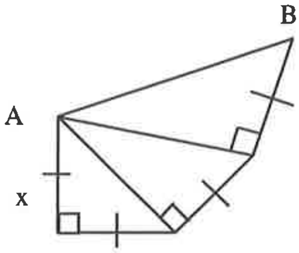
$\frac{2x}{y} + \frac{2x}{z}$ equals

A $\frac{4x}{x+y}$
B $\frac{2x}{y+z}$
C $\frac{2x}{yz}$
D $\frac{2xz+2xy}{yz}$
E $\frac{2xz+2xy}{y+z}$

50. $\frac{13.7 \times 0.006}{0.87}$ is nearest in value to

A 0.001
B 0.01
C 0.1
D 1
E 10

51.



The length of AB is

A 2x
B $2\sqrt{x}$
C $\sqrt{2x}$
D $4x^2$
E 4x.

52. Susan travels from town A to town B, 480 km apart, at 80 km/h. Her return journey is travelled at 120 km/h. Her average speed for the journey to town B and back is

A 100 km/h
B 80 km/h
C 120 km/h
D 96 km/h
E 40 km/h

53. If $\frac{2x-5}{3} > \frac{6-x}{2}$ then x is

A < 8
B < 28
C < 4
D > 5.6
E > 4

54. The area of a circle is directly proportional to the radius of the circle squared. i.e. $A \propto r^2$

If we double the radius, the Area is

A Doubled
B Quadrupled
C Halved
D Quartered
E Squared.

55. The point (2,1) lies on the curve

$y = x^2 - 2x + k$. k is equal to

A - 3
B - 1
C 1
D 3
E 5

APPENDIX C

Mathematics

Achievement Test 10B

Year 10

Directions

This is a test of your understanding and skill in mathematics_ The questions in the test are like the practice examples below. Five answers are given for each question. You are to chooseone answer you think best.

PRACTICE QUESTIONS

P1 The number which is 2 less than 9

A 6
B 8
C 7
D 9
E 10

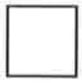
The best answer is 7. You will see the number 7 has the letter C in front of it

Now take your Answer Sheet to see how the answer should be filled in
Look at the section which starts with Practice Questions . Beside P1 are the letters A, B, C, D and E. As the correct answer for P1 is C the circle under C has been filled in.

You must mark all your answers on your Answer Sheet like this

P2 Which of these shapes is a circle.

A 

B 

C 

D None of the above

Decide which of the answers is correct, then make your answer next to P2 on the Answer Sheet

The correct answer is D because none of the answers given in A,B,C, or D is correct, If you marked another letter, rub it out and mark the correct letter, If you want to change your answer, rub out the mark completely.

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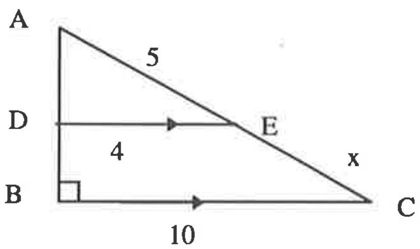
1.



If DE is parallel to BC the length of x is

A 12·5
B 7·5
C 5
D 10
E 6·5

2. A(-5,7) and B(3,-3) are two points

The mid point, M, of the line AB is

A (-2, 4)
B (-8, 10
C (-1, 2)
D (1, - 2)
E (2, - 4)

3. The slope of the line perpendicular to AB is

A $\frac{4}{5}$
B $-\frac{5}{4}$
C -2
D $\frac{5}{4}$
E 0

4 When $\frac{5}{2\sqrt{5}}$ is simplified to have a rational denominator it becomes

A $\frac{\sqrt{5}}{2}$
B ½
C $\frac{25}{4}$
D $\frac{5}{4}$
E $\frac{\sqrt{5}}{10}$

5. When a number is increased by 7 and the result is divided by 4, the answer is twice the original number. The number is equal to

A 7
B 3.5
C - 1
D 1
E $\frac{7}{4}$

6 $4^{-1} - 4^{0}$ is equal to

A - 4
B - 0.75
C - 1.25
D - 3
E - 5

7. A straight line has the equation y = ½ x + 5
The line cuts the y axis at

A 5
B 10
C 2.5
D - 5
E - 10

8. If $A = 2\sqrt{\frac{Y}{x}}$ then y is equal to

A $2Ax$

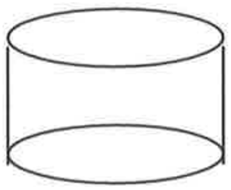
B $\frac{Ax}{2}$

C $\frac{Ax}{4}$

D $4A^2x$

E $\frac{xA^2}{4}$

9.



The cylinder has a diameter of 14cm and a height of 5 cm. Its volume in terms of π is

A $\frac{245\pi}{2}$

B 245π

C 490

D $\frac{490\pi}{2}$

E 70π

10. The depth of water in a bath t seconds after the plug is removed is given by

$$D = 24 \times 2^{-\frac{t}{2}} \text{ cm}.$$

The depth of water at the instant the plug was removed is

A 48 cm.

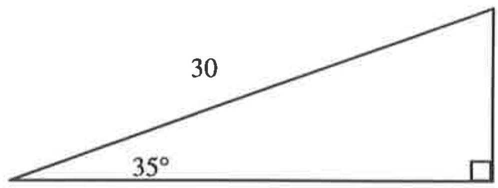
B 24 cm.

C 12 cm.

D 1 cm.

E 2 cm.

11. The value of x in the triangle below is



A $30^2 - \sin^2 35^0$

B $30.\sin 35^0$

C $30.\cos 35^0$

D $\sin 35^0$

E $\cos 35^0$

12. The average of

13, 2, 9, 7, 2, 5, 11 is equal to

A 49

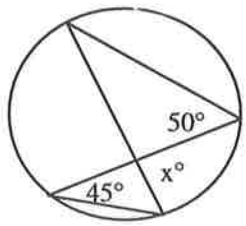
B 7

C 6

D 13

E 2

13.



The value of x is

A 50°

B 95°

C 45°

D 90°

E 85°

14. If the lines with equations 6x + 2y = 5 and - 3x + ky = 6 are parallel, the value of k is

A - 2

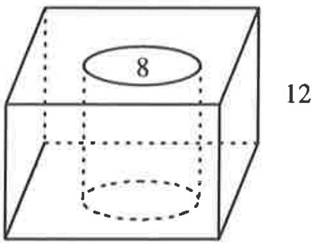
B 1

C - 1

D 4

E 3

15.



The diagram represents a cubic solid of side 12cm. There is a circular hole of diameter 8cm drilled vertically through the solid. The volume of the remainder, in terms of ~ is

A $12^3 - 192\pi$
B $144 - 192\pi$
C $36 - 192\pi$
D $12^3 - 768\pi$
E $144 - 768\pi$

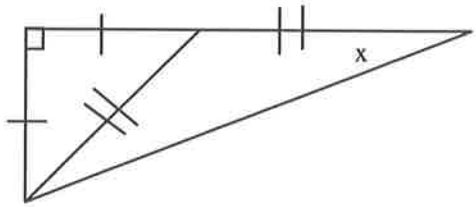
16. $10y^2 \div (5y)^2$ can be simplified to

A 2y
B 2
C 0.4
D 5
E $5y^4$

17. If 3x + 2y = 4 and x - 4y = -1 then x and y are

A (½, 1)
B (1, ½)
C (-1, 2)
D (7, 6)
E (2, -1)

18



The value of the angle x is

A 30^0
B 62.5^0
C 45^0
D 22.5^0
E 60^0

19 If $9^{x+1} = \frac{1}{81}$, then x is equal to

A - 1
B 3
C 2.5
D 1
E - 3

20. In simplest surd form $\sqrt{75} + \sqrt{27}$ equals

A $\sqrt{102}$
B $2\sqrt{3}$
C $15\sqrt{3}$
D $8\sqrt{3}$
E $8\sqrt{6}$

21 The mid point of the segment joining A(-2,5) and B(x,y) is equal to M (1,6) then the value of B is

A $(\frac{-1}{2}, \frac{1}{2})$
B (- 1, 11)
C (4, 7)
D (1, 6)
E (3, 6)

22. $3\sqrt{27} + \sqrt{64} - \sqrt{\frac{121}{4}}$ is equal to

A 5.5
B - 7
C 7
D 60.75
E 2

23. If $\frac{2x}{3} - 1 = 7$, then x equals

A 21
B 9
C 12
D 24
E 18

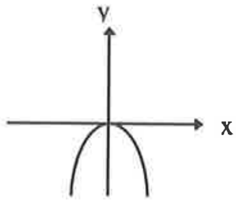
24. The length of a rectangular lawn is 4m greater than its breadth. If the breadth is xm and the area is 192 m^2, an equation which may be used to find the breadth of the lawn is

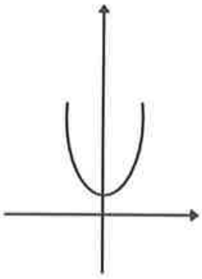
A $2x + 4 = 192$
B $4x + 8 = 192$
C $4x^2 = 192$
D $x^2 + 4x = 192$
E $x^2 - 4x = 192$

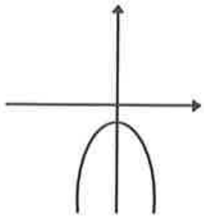
25 The positive number when increased by 30 will be 26 less than its square will be, then the number is

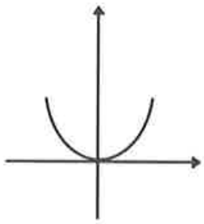
A 28
B 8
C - 8
D - 7
E 7

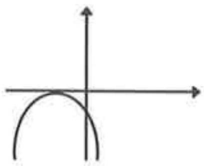
26. Which of the following graphs is described by $y = \frac{x^2}{2}$

A


B


C


D


E


27. The graphs representing

$-3x + 2y = 10$ and
$9x - 6y = -30$ have

A no points in common
B one point in common
C three points in common
D two points in common
E more than three points In common

28. There are two values of p for which $p^2 - 5p = -6$. The two values are

A 1 and 6
B - 3 and 2
C 2 and 3
D - 1 and 6
E - 5 and - 1

29. . $12m^2$ is equal to

A $12000\ mm^2$
B $120000\ mm^2$
C $1200\ mm^2$
D $1200000\ mm^2$
E $12000000\ mm^2$

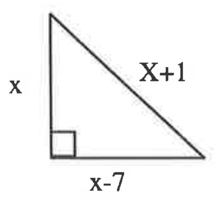
30. $\sqrt[3]{-27} =$

A - 3
B 9
C - 9
D 3
E $\frac{-1}{3}$

31. When factorised completely $(x-5)^2 - 16$ equals

A 4(x-9)
B (x - 4) (x + 4
C (x -3) (x+3)
D (x - 1) (x - 9)
E 4(x - 1)

32. The sides of the triangle are equal to



A 3, 4, 5
B 5, 12, 13
C 7, 8, 9
D 16, 17, 9
E 4, 5, -3

33 For all real numbers a and b, a - b equals

A $\frac{a^2 - b^2}{a - b}$
B $(\sqrt{a} - \sqrt{b})^2$
C $(\sqrt{a} - \sqrt{b})(\sqrt{a} + \sqrt{b})$
D $\frac{a^2 + b^2}{a + b}$
E $\frac{(a+b)^2}{a - b}$

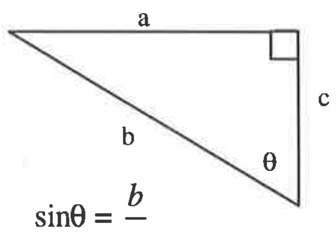
34. If $x * y = \sqrt{x} + \sqrt{y} - \sqrt{xy}$, then 9 * 16 equals

A -1
B 11
C -5
D 7
E -7

35. $9^n \times 81^n$ is equal to

A 3^{6n}
B 3^{2n}
C 3^{8n}
D 9^n
E 9^{2n}

36 For the diagram shown below, which <u>one</u> of the following statements is correct?

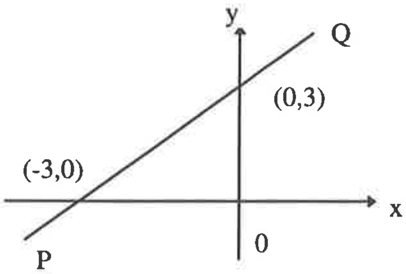


A $\sin\theta = \frac{b}{c}$
B $\cos\theta = \frac{b}{c}$
C $\tan\theta = \frac{a}{c}$
D $\sin\theta = \frac{a}{c}$
E $\cos\theta = \frac{c}{a}$

37. If $\frac{X^2+Y^2}{Z^2} = P^2$ then Y is equal to

A $PZ - X$
B $\frac{P}{Z} - X$
C $P^2Z^2 - X^2$
D $\sqrt{P^2Z^2 - X^2}$
E $\sqrt{P^2Z^2 + X^2}$

38



The equation of PQ is

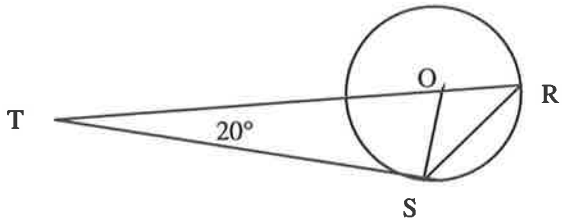
A y = 2x + 3
B y = 2x - 3
C y = x - 3
D y = -x +3
E y = x +3

39 If $\sin x° = \frac{4}{5}$ and $\cos x° = \frac{-3}{5}$

then tan x° equals

A $\frac{4}{3}$
B $\frac{3}{4}$
C $\frac{-12}{25}$
D $\frac{-3}{4}$
E $\frac{-4}{3}$

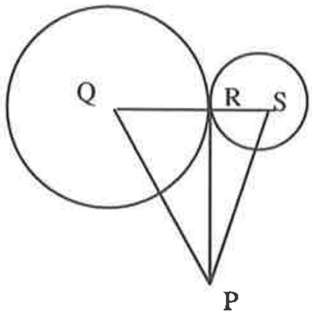
40 .



TS is the tangent at S to the circle, centre O. ∠SRT equals

A 20°
B 25°
C 35°
D 40°
E 50°

41.



Two unequal circles centres Q and S touch at R. PR is a common tangent.

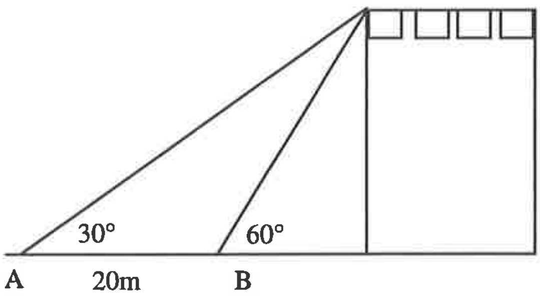
In ΔPQS, PR is

A a median
B an altitude
C the bisector of ∠ QPS
D the perpendicular bisector of QS
E none of these.

42. If x is proportional to the square of t, and when x = 40, t = 2, the law connecting x and t is

A $x = 4t^2$
B $x = 20t^2$
C $x = 10t^2$
D $x = 5t^2$
E $x = t^2$

43.



To calculate the height of the wall of an old castle a surveyor measured the angle of elevation from a point A to the top of the wall to be 30° When moving to the point B 20m closer, on the same horizontal plane, the angle of elevation was found to be 60°. The height of the wall is.

A $5\sqrt{3}$
B $10\sqrt{3}$
C $15\sqrt{3}$
D 30
E 40

APPENDIX D_1

ANXIETY TESTS
IN
MATHEMATICS

SCHOOL.............................

CHRISTIAN NAME.................................

SURNAME...

TICK IF A BOY ☐

TICK IF A GIRL ☐

YEAR 6

DIRECTIONS

This is a test of your level of anxiety in mathematics. The test will help you decide what sections of your mathematics course cause you **no worry at all, a little worry**, **a fair amount of worry**, **a lot of worry**, or **an awful lot of worry**.

For each of the 47 items, decide the level of your worry or anxiety and mark your paper according to the following scale:

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
(a)	X				
(b)		X			
(c)			X		
(d)				X	
(e)					X

There is no time limit, but work rapidly and do not spend too much time on any one item. Be sure to answer every item. Remember that you mark only one answer for each item.

Before you begin the test, put your name, school and whether you are a boy or a girl in the spaces provided.

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
1. Not finishing mathematics work in class.					
2. Remembering a phone number.					
3. Explaining a maths problem in front of the class.					
4. Understanding the meaning of PERIMETER.					
5. Having to start mathematics homework.					
6. Understanding a bus timetable.					
7. Listening to the teacher explain a new topic.					
8. The need to know the meaning of maths abbreviations.					
9. Using mathematics charts.					
10. Understanding word problems.					
11. Explaining the meaning of a number squared.					
12. Having to divide by a decimal.					
13. Trying to complete maths puzzles in newspapers.					
14. Arranging fractions in ascending order.					
15. Dividing two fractions.					
16. Knowing all multiplication tables.					
17. Understanding the meaning of VOLUME.					
18. Having to ask a classmate for help with a problem.					

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
19. The teacher asking me questions about mathematics.					
20. Carrying out the multiplication process.					
21. Calculating money in the deli.					
22. Changing metres to kilometres.					
23. Arranging decimals in order of size.					
24. Having to work out the multiples of numbers.					
25. Adding fractions.					
26. Having to tell the time on a clock face.					
27. Changing kilograms to grams.					
28. Doubling numbers in my head.					
29.Simplifying fractions.					
30. Having to carry out mental addition.					
31. Comparing a number of different prices in a store.					
32.Having to square numbers.					
33. Multiplying a decimal by another decimal.					
34. Changing centimetres to millimetres.					
35. Changing decimals to fractions.					
36. Drawing accurate circles.					
37. Carrying out mental division.					
38. Having to recite my multiplication tables.					
39. Changing fractions to decimals.					

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
40. Measuring in mm or cm.					
41. Organizing my lunch money at school.					
42. Dividing decimals by decimals.					
43. Calculating accurately the weight of an object.					
44. Visualizing difficult addition in my head.					
45. Changing an improper fraction to a whole number and a fraction.					
46. Calculating the change I should have after buying something.					
47. Calculating the number of days in half a year.					

APPENDIX D_2

ANXIETY TESTS
IN
MATHEMATICS

SCHOOL...............................

CHRISTIAN NAME................................

SURNAME...

TICK IF A BOY ☐

TICK IF A GIRL ☐

YEAR 7

DIRECTIONS

This is a test of your level of anxiety in mathematics. The test will help you decide what sections of your mathematics course cause you **no worry at all**, **a little worry**, **a fair amount of worry**, **a lot of worry**, or **an awful lot of worry**.

For each of the 47 items, decide the level of your worry or anxiety and mark your paper according to the following scale:

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
(a)	**X**				
(b)		**X**			
(c)			**X**		
(d)				**X**	
(e)					**X**

There is no time limit, but work rapidly and do not spend too much time on any one item. Be sure to answer every item. Remember that you mark only one answer for each item.

Before you begin the test, put your name, school and whether you are a boy or a girl in the spaces provided.

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
1. Working out word problems in mathematics.					
2. Finding the PERIMETER of irregular shapes.					
3. Understanding the concept of AREA.					
4. Asking the teacher to help with a maths problem.					
5. Converting **gm** to **kg**					
6. Understanding the concept of one line PERPENDICULAR to another.					
7. The concept of an ACUTE ANGLE.					
8. Calculating the AREA of a rectangle.					
9. Changing decimals to fractions.					
10. Understanding what a PRIME NUMBER is.					
11.Understanding the concept of SPEED.					
12. Having to calculate the number of hours in a week.					
13. Understanding what is meant by an OBTUSE angle.					
14. Changing years to months.					
15. Explaining what a CHORD is.					
16. Multiplying fractions.					
17. The meaning of LOWEST COMMON MULTIPLE.					
18. Writing numbers as products of PRIME NUMBERS.					
	Does not	Worries	Worries	Worries	Worries

	worry me at all.	me a little.	me a fair amount.	me a lot.	me an awful lot.
19. The concept of a STRAIGHT ANGLE.					
20. Changing fractions to Equivalent Fractions.					
21. Dividing a number by a fraction.					
22. What is an ISOSCELES TRIANGLE.					
23. Changing mm to cm.					
24. Placing numbers on a NUMBER LINE.					
25. Calculating the CIRCUMFERENCE of a circle.					
26. Converting decimals to fractions.					
27. If 3 Balloons cost $36, finding the cost of 5 balloons.					
28. Carrying out simple division in my head.					
29.Approximating decimals to the nearest whole number.					
30. The difference between LENGTH and AREA.					
31. Having to remember my MULTIPLICATION TABLES.					
32. The concept of a COMMON FACTOR.					
33. Changing cubic centimetres to LITRES.					
34. Identifying the different parts of a circle.					
35. Calculating the SQUARE ROOT of a number.					

36. When the teacher asks maths questions requiring an answer only.					
37. Multiplying three whole numbers at one time.					
38. The concept of a CUBIC METRE.					
39. Understanding the **greater than** or **less than** symbols.					
40. Having to find patterns in a group of numbers.					
41. Finding the length of the side of a square knowing its perimeter.					
42. Writing fractions in ASCENDING order.					
43. What a REFLEX Angle is.					
44. Changing fractions to decimals.					
45. Simplifying fractions.					
46. Adding up groups of numbers.					
47. Having to carry out LONG DIVISION					

APPENDIX D_3

ANXIETY TESTS
IN
MATHEMATICS

SCHOOL..............................

CHRISTIAN NAME................................

SURNAME..

TICK IF A BOY ☐

TICK IF A GIRL ☐

YEAR 8

DIRECTIONS

This is a test of your level of anxiety in mathematics. The test will help you decide what sections of your mathematics course cause you **no worry at all**, **a little worry**, **a fair amount of worry**, **a lot of worry**, or **an awful lot of worry**.

For each of the 47 items, decide the level of your worry or anxiety and mark your paper according to the following scale:

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
(a)	**X**				
(b)		**X**			
(c)			**X**		
(d)				**X**	
(e)					**X**

There is no time limit, but work rapidly and do not spend too much time on any one item. Be sure to answer every item. Remember that you mark only one answer for each item.

Before you begin the test, put your name, school and whether you are a boy or a girl in the spaces provided.

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
1. Understanding the meaning of a "Number Squared".					
2. Using Mathematical formulae.					
3. Working out Word Problems in Mathematics					
4. What PROBABILITY means.					
5. Explaining a problem in front of the class.					
6. Reading angles from a protractor or geoliner.					
7. Trying to understand what PERIMETER means.					
8. Reading a bus or tram timetable.					
9. Understanding the meaning of POLYGON.					
10. Having to use abbreviations such as: kg, mm, km.					
11. Listening to the teacher explain a new Arithmetic problem.					
12. What PRIME NUMBER means.					
13. Reading answers from a table of values.					
14. Dividing whole numbers by deecimals.					
15. Trying to understand Arithmetic puzzles in newspapers and magazines.					
16. Understanding the meaning of VENN DIAGRAMS.					
17. Constructing equations from graphs.					
18. Trying to understand ALGEBRAIC ADDITION.					
19. The concept of AREA.					
20. Asking teacher to help me with a problem I don't understand.					
21. Understanding what VOLUME means.					

	Does not worry me at all.	Worries me a little.	Worries me a fair amount	Worries me a lot.	Worries me an awful lot.
22. Teacher asking Mathematics questions around the class.					
23. Working multiplication problems.					
24. Understanding what PERCENTAGE means.					
25. Having to calculate the correct money at the supermarket or deli.					
26. Converting metres to kilometres.					
27. Trying to understand ALGEBRAIC MULTIPLICATION.					
28. Finding multiples of a number.					
29. Adding one fraction to another.					
30. Understanding numbers written in INDEX NOTATION.					
31. Carrying out simple division in my head.					
32. Converting grams to kilograms.					
33. Doubling numbers in my head.					
34. Simplifying fractions.					
35. Adding up quickly in my head.					
36. Comparing prices in a shop or school canteen.					
37. Finding the square of a number.					
38. Understanding the GREATER THAN and LESS THAN symbols.					
39. Changing centimetres to millimetres.					
40. Calculating AREAS of TRIANGLES.					
41. Subtracting numbers in my head.					
42. Picturing THREE DIMENSIONAL objects on paper.					

	Does not worry me at all.	Worries me a little.	Worries me a fair amount	Worries me a lot.	Worries me an awful lot.
43. Accurately reading measurements.					
44. The concept of SPEED.					
45. Changing fractions to decimals.					
46. Approximating decimals to the nearest whole number.					
47. What SURFACE AREA means.					

APPENDIX D_4

ANXIETY TESTS
IN
MATHEMATICS

SCHOOL...............................

CHRISTIAN NAME.................................

SURNAME..

TICK IF A BOY ☐

TICK IF A GIRL ☐

YEAR 9

DIRECTIONS

This is a test of your level of anxiety in mathematics. The test will help you decide what sections of your mathematics course cause you **no worry at all**, **a little worry**, **a fair amount of worry**, **a lot of worry**, or **an awful lot of worry**.

For each of the 47 items, decide the level of your worry or anxiety and mark your paper according to the following scale:

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
(a)	X				
(b)		X			
(c)			X		
(d)				X	
(e)					X

There is no time limit, but work rapidly and do not spend too much time on any one item. Be sure to answer every item. Remember that you mark only one answer for each item.

Before you begin the test, put your name, school and whether you are a boy or a girl in the spaces provided.

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
1. Understanding the meaning of a "Number Squared".					
2. Using Mathematical formulae.					
3. Working out Word Problems in Mathematics.					
4. What Probability means.					
5. Explaining the concept of GRADIENT or SLOPE.					
6. Interpreting graphs of lines and curves.					
7. Trying to understand what PERIMETER means.					
8. Reading a bus or tram timetable.					
9. Understanding the meaning of POLYGON.					
10. Having to use abbreviations such as km, mm, kg.					
11. Listening to the teacher explain a new ALGEBRA topic.					
12. What PRIME NUMBER means.					
13. Identifying the different parts of a CIRCLE.					
14.Carrying out DIVISION in ALGEBRA.					
15. Understanding Mathematical Puzzles in newspapers and magazines.					
16. Numbers written in SCIENTIFIC NOTATION.					
17. Constructing Equations from Graphs.					
18. Trying to understand ALGEBRAIC ADDITION.					
19. The concept of AREA.					
20. Asking teacher to help me with a problem I don't understand.					
21. Understanding what VOLUME means.					
22. Teacher asking GEOMETRY questions around the class.					
23. Constructing Graphs from a table of values.					

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
24. Calculating the areas of CIRCLES.					
25. Trying to understand ALGEBRAIC MULTIPLICATION.					
26. Finding the CUBE ROOT of a number.					
27. Adding one Fraction to another.					
28. Understanding numbers written in INDEX NOTATION.					
29. Carrying out simple division in my head.					
30. Finding the CUBE of a number.					
31. Doubling numbers in my Head.					
32. Simplifying ALGEBRAIC FRACTIONS.					
33. Adding up quickly in my head.					
34. Comparing prices in a shop or school canteen.					
35. Finding the SQUARE ROOT of a number.					
36. Understanding the GREATER THAN and LESS THAN symbols.					
37. Rearranging formula.					
38. Carrying out SUBTRACTION in ALGEBRA.					
39. Converting DECIMALS to FRACTIONS.					
40. Using the SQUARE ROOT button on the calculator.					
41. Accurately reading measurements from GRAPHS.					
42. The concept of SPEED.					
43. Changing fractions to decimals.					
44. The concept of SIGNIFICANT FIGURES.					
45. What SURFACE AREA means.					

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
46. Using the INVERSE SQUARE ROOT button on the calculator.					
47.Picturing THREE DIMENSIONAL objects on paper.					

APPENDIX D_5

ANXIETY TESTS
IN
MATHEMATICS

SCHOOL..............................

CHRISTIAN NAME................................

SURNAME..

TICK IF A BOY ☐

TICK IF A GIRL ☐

YEAR 10A

DIRECTIONS

This is a test of your level of anxiety in mathematics. The test will help you decide what sections of your mathematics course cause you **no worry at all**, **a little worry**, **a fair amount of worry**, **a lot of worry**, or **an awful lot of worry**.

For each of the 47 items, decide the level of your worry or anxiety and mark your paper according to the following scale:

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
(a)	X				
(b)		X			
(c)			X		
(d)				X	
(e)					X

There is no time limit, but work rapidly and do not spend too much time on any one item. Be sure to answer every item. Remember that you mark only one answer for each item.

Before you begin the test, put your name, school and whether you are a boy or a girl in the spaces provided.

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
1. Understanding the meaning of a NUMBER SQUARED.					
2. Rearranging formulae.					
3. Working out Word Problems in Mathematics.					
4. The meaning of PROBABILITY.					
5. The concept of GRADIENT or SLOPE.					
6. Interpreting graphs of lines and curves.					
7. The meaning of PERIMETER.					
8. Trying to solve SIMULTANEOUS EQUATIONS.					
9. Identifying the different parts of a CIRCLE.					
10. Carrying out DIVISION in ALGEBRA.					
11. Understanding MATHEMATICAL PUZZLES in magazines and newspapers.					
12. The DIFFERENCE of TWO SQUARES in factorization.					
13. Constructing equations from graphs.					
14. The concept of AREA.					
15. Trying to understand ALGEBRAIC MULTIPLICATION.					
16. The concept of a CHORD of a CIRCLE.					
17. Understanding the SQUARE ROOT of a NUMBER.					
18. Asking teacher to help me with a problem I don't understand.					
19. Understanding what VOLUME means.					
20. Teacher asking questions around the class.					
21. Simplification of problems like $(2x+3)^2$.					
22. Finding the CUBE ROOT of a number.					

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
23. Understanding the MULTIPLICATION RULE of INDICES.					
24.Using the PYTHAGORAS formula.					
25. Simplifying ALGEBRAIC fractions.					
26. Finding the 'y' INTERCEPT of a graph.					
27. Finding the CUBE of a number.					
28. Carrying out ADDITION in ALGEBRA.					
29. Accurately reading MEASUREMENTS from graphs.					
30. Understanding the symbols of $\geq$ and $\leq$.					
31. Picturing THREE-DIMENSIONAL OBJECTS on paper.					
32. The concept of ANGLES IN THE SAME SEGMENT OF A CIRCLE.					
33. Having to simplify problems of the type $a^m.a^n$					
34. The concept of COMMON FACTORS.					
35. Identifying AN ANGLE IN A SEMI-CIRCLE.					
36. Finding the SLOPE of a LINE.					
37. Identifying PERFECT SQUARES in factorization.					
38. Finding the 'x' INTERCEPT of a graph.					
39. The concept of PERPENDICULARITY.					
40. The concept of SIMILAR FIGURES.					
41. Changing FRACTIONS to DECIMALS.					
42. The RULES of CONGRUENCY.					
43. Using the MID-POINT formula in Co-ordinate Geometry.					
44.Collecting LIKE TERMS in Algebra.					

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
45. Simplifying problems of the type $(a^2)^3$.					
46. Calculating the AREAS of CIRCLES.					
47. Having to find the VERTEX of a PARABOLA.					

APPENDIX D_6

ANXIETY TESTS
IN
MATHEMATICS

SCHOOL.............................

CHRISTIAN NAME................................

SURNAME...

TICK IF A BOY ☐

TICK IF A GIRL ☐

YEAR 10B

DIRECTIONS

This is a test of your level of anxiety in mathematics. The test will help you decide what sections of your mathematics course cause you **no worry at all**, **a little worry**, **a fair amount of worry**, **a lot of worry**, or **an awful lot of worry**.

For each of the 47 items, decide the level of your worry or anxiety and mark your paper according to the following scale:

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
(a)	X				
(b)		X			
(c)			X		
(d)				X	
(e)					X

There is no time limit, but work rapidly and do not spend too much time on any one item. Be sure to answer every item. Remember that you mark only one answer for each item.

Before you begin the test, put your name, school and whether you are a boy or a girl in the spaces provided.

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
1. Understanding the meaning of a NUMBER SQUARED.					
2. Calculating the AREA of a CIRCLE.					
3. Working out Word Problems in Mathematics.					
4. Solving PROBABILITY problems.					
5. Finding the GRADIENT or SLOPE of a line.					
6. Interpreting graphs of lines and curves.					
7. Using TRIGONOMETRY to solve problems.					
8. Solving SIMULTANEOUS EQUATIONS.					
9. Identifying the CHORDS of a CIRCLE.					
10. Having to find the SINE of an ANGLE.					
11. Knowing the MAXIMUM and MINIMUM values of $y = \text{Cos}\,\theta$					
12. Understanding the meaning of PERIMETER.					
13. Having to find θ knowing the value of $\tan \theta$.					
14. Calculating the VOLUME of a regular container.					
15. Carrying out ALGEBRAIC MULTIPLICATION.					
16. The cencept of ANGLES IN A SEMI-CIRCLE.					
17. Understanding the SQUARE ROOT of a number.					
18. Having to sketch the graph of $y = \sin \theta$					
19. Solving TRIGONOMETRIC EQUATIONS.					
20. The concept of a TANGENT to a CIRCLE.					
21. Simplification of problems like $(2x + 3)^3$					
22. Finding the CUBE ROOT of a number.					

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
23. Calculating the VOLUME of a SPHERE.					
24. Using SIMILAR TRIANGLES to solve problems.					
25. Simplifying indices of the form $(\sqrt{a^3})^{-3}$					
26. Using the PYTHAGORAS theorem.					
27. Simplifying ALBEBRAIC FRACTIONS.					
28. Finding the 'y' intercept of a graph.					
29. Finding the CUBE of a number.					
30. Having to identify COMMON FACTORS.					
31. Accurately reading measurements from GRAPHS.					
32. Understanding the $\geq$ and $\leq$ symbols.					
33. Using the COSINE of an angle.					
34. Using the DISTANCE FORMULA.					
35. Having to simplify problems of the type $a^m . a^n \div a^p$.					
36. Recognizing the DIFFERENCE of SQUARES.					
37. Identifying ANGLES in a SEMI-CIRCLE.					
38. Accurately drawing PARABOLIC graphs.					
39. Identifying PERFECT SQUARES in factorization.					
40. Finding the 'x' intercept of a graph.					
41. Finding the NEGATIVE INVERSE of a number.					
42. The concept of SIMILAR FIGURES.					
43. Having to COMPLETE THE SQUARE.					
44. The rules of CONGRUENCY.					
45. Using the MID POINT formula in Co-ordinate Geometry.					

	Does not worry me at all.	Worries me a little.	Worries me a fair amount.	Worries me a lot.	Worries me an awful lot.
46. Using the DISTANCE FORMULA in Co-ordinate Geometry.					
47. Simplifying problems of the type $(a^{-2})^{-3}$.					

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Replace Sarason (1952) by
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