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AN ANALYSIS OF GENDER RELATED DIFFERENCES IN PERFORMANCE AND ATTITUDES OF PARTICIPANTS IN THE 1997 UCT MATHEMATICS COMPETITION

by

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ABSTRACT

In this study, possible gender differences in and attitudes towards mathematics will be investigated. As a sample, the candidates taking part in the individual competition in the University of Cape Town Mathematics Competition will be used. This sample has been chosen since it appears that even though the gender related differences in performance that are reported are often very small, the differences are often more apparent at the upper end of the ability scale. Since the University of Cape Town Mathematics Competition attracts entries from candidates of wide ranging ability, a number of investigations can be done. The investigations that will be carried out included statistical analyses of a number of different categories in mathematics (algebra, arithmetic, geometry and problem solving), various sub-categories and special categories; questions that have been repeated in more than one question paper will also be investigated for any patterns in performance (in terms of maturity in mathematics).

Since learners engaging in mathematical activities (including participating in mathematics competitions) are affected by external and internal influences on their perception and attitudes towards mathematics, it was felt that an investigation into the relationship between performance in mathematics and attitudes towards mathematics was important. Gender related differences in attitudes towards mathematics will also be investigated.

The results of this study will show that, where statistically significant differences in performance exist, these differences are in fact very small. The results of the attitudes questionnaire demonstrate that there is a statistically significant correlation between attitudes and performance in mathematics and that there exists small, yet statistically significant differences in attitudes towards mathematics.

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INTRODUCTION

Background

The University of Cape Town Mathematics Competition has been in existence (in its present form) for 18 years. It grew out of a small "Mini-Maths Olympiad" which was started by two local Mathematics teachers, Mrs Mona Leeuwenburg and Ms Shirley Fitton, in 1977. As a result of its popularity, the Competition had to be moved to the campus of the University of Cape Town in 1980, since no local school had the capacity to provide the facilities for such a large number of pupils (Webb, 1996). One of the "unique" aspects of the University of Cape Town Mathematics Competition is that all the candidates who take part, write the papers on the campus. In the last eleven years participation in the individual competition has remained relatively constant at around 1600-1700 candidates. There are two branches to the Competition: there is the individual competition as well as the very popular pairs competition, where students from the same school pair up and complete the papers on a collaborative basis. The Competition is open to all schools within a radius of 200km from Cape Town and each school is invited to enter five individuals and four pairs per Grade (up until 1995 the participating schools were only allowed to enter three pairs per Grade). The Prize Giving is held about one month after the writing of the Competition. The top ten individual candidates as well as the top three pairs in each grade receive a Gold Award Certificate.

Interest

As a teacher at an all girls school and as a participant when I was at school, I noticed that there were very few (if any) girls receiving awards in either the individual or the pairs competition. Since the school at which I teach was always placed within the top twelve schools (and was the top girls school for a number of years), this seemed to suggest that the girls were not doing as badly as it appeared at the Prize Giving. On the whole, the performance of the two genders seemed similar and yet the males seemed to outperform the females at the upper end of ability. It was here that I first became interested in these apparent differences in performance in the University of Cape Town Mathematics Competition. After informal conversations with my own students, it appeared that they did not seem to rate their own ability as comparable to those who achieve well in the Competition. It seemed that they lacked confidence in their ability although it was clear to me that they were competent in class.

It was not only the gender related differences in overall performance that were of interest. It was also of interest to investigate whether there were specific areas of mathematics in which there were significant differences (statistically or educationally) in performance and if there were any categories that displayed similarities in performance. I was also interested in investigating those questions which appeared in more than one paper, to attempt to establish whether any patterns exist for any differences in performance, whether these differences are gender related or are entirely due to maturity in mathematics, or are due to a combination of these factors.

Since performance in mathematics is not isolated from external and personal factors, it was also of interest to investigate the attitudes of the participants in the University of Cape Town Mathematics Competition. Thus a further aspect in this study will be to make observations about any patterns in differences in attitudes that become evident from the analysis of the Attitudes Questionnaire drawn up. An attempt will also be made to draw some conclusions about the relationship of specific attitudes and the relative performance in the University of Cape Town Mathematics Competition.

Overview

In Chapter 1, a literature survey has been conducted. There are two main sections within this survey:

- the first section of the survey will report on the literature that has investigated the gender related differences in performance in mathematics. An overview of the specific types of problems on which statistically significant differences have been found, will be given. The research on the types of skills required to perform well in mathematics is reviewed and a model is given which attempts to explain the observed differences. An attempt is also made to report on some of the proposed causes (such as type of school and culture) of these gender related differences in performance in mathematics.
- the second section of the literature survey provides an overview of the "popular" view of mathematics; different areas of attitudes are also explored together with details of any gender related differences. The relationship of attitude with performance is also explored.

Chapter 2 is a detailed account of the methodology employed in the research. The background to the setting of the papers in the University of Cape Town Mathematics Competition is given, as well as the setting up of the attitudes questionnaire. Within this chapter the methods used for the data analysis will also be described.

Chapter 3 and Chapter 4 contain the results and discussion for the two areas of interest: performance in the University of Cape Town Mathematics Competition and the attitudes of the candidates taking part in this competition.

Chapter 5 contains a final discussion and the conclusions reached from the study. The implications of this study will be discussed within the context of education in South Africa. Within this chapter, some suggestions for further investigations will be made.

LITERATURE SURVEY: MATHEMATICS AND GENDER

The marginalisation of women in education has been practised for centuries and it is only recently (in the last 50 years or so) that many of the tertiary institutions previously single-sex (most often men only) started admitting women to the colleges. Examples include Harvard and Columbia Universities in America and Oxford and Cambridge in England. In fact, it is now 50 years since Cambridge first allowed women to receive a degree. It was in 1890 that Philippa Fawcett wrote the Mathematical Tripos at Cambridge and it was in this year that she was placed "Above the Senior Wrangler". Officially she was not recognised as receiving the highest honours in this examination since she was a women (Siklos, 1990). It was commonly thought that women were capable of studying advanced subjects like mathematics but that they should not, since "(a) young woman might learn algebra, but .. when the limited sum of energy flowed to the overwrought brain, it harmed the natural growth of the ovaries." (Tyack and Hansot, cited in Grouws, 1992, p 598) This was the argument put forward by Dr Edward Clarke in his opposing the admission of women to Harvard in the 1870's. There were, however, other institutions like the Oberlin College in Ohio that admitted men and women of all races (in 1833) thus challenging the existing beliefs and norms of the (academic) society.

To this day many studies examined the gender differences in mathematics. These studies have had two main areas of focus - gender related differences in performance in mathematics and gender related differences in attitudes. The next two sections will be devoted to outlining some of the current research in these two areas.

Gender related differences in performance in mathematics.

Gender related differences in achievement in mathematics are often quoted from studies (particularly in the earlier years of research into this area) in which the number of mathematics courses taken by the subjects was not controlled. Comparisons were made and inferences drawn from samples in which the males most often had taken more courses in mathematics (i.e. were mathematically better educated) than the females (Jacobs, 1978). Clearly the effect was to bias the results in favour of the males. This, however, is not to say that differences do not occur. It seems to be a general consensus that differences are not evident in the earlier school years and when the differences appear (if at all) then the differences are almost always in favour of the males (Jacobs, 1978). In the elementary and middle school years (primary school) there does appear to be a slight female superiority, whereas in the high school, college and adult years males seem to enjoy a substantial superiority over females (Frost, Hyde and Fennema, 1994, Moore and Wade Smith, 1987). Opyene-Eluk and Opolot-Okurut (1995) have found that in Uganda, gender related differences appear as early as in the primary school years (ages 6 to 12 years old). Stage, Kreinberg, Eccles and Becker (cited in Hyde, Fennema and Lamon, 1990) stated that "(t)here is some evidence, however, that the general pattern of sex differences may emerge somewhat earlier among gifted and talented students" (p. 140). Visser (1987) has found the following with regard to the South African situation

> A nation-wide mathematics olympiad is arranged annually for mathematically gifted students. In the period 1966-1985 only 12 females gained silver medals as against the 183 silver medals awarded to males. No gold medal has yet been awarded to a female, and in 1986 only five females as against 98 males progressed to the final round of the olympiad. The latter differences cannot be explained by differences in

> mathematics course participation, because the same curriculum is followed by all mathematics students.
>
> (Visser, 1987, p. 138)

In 1997, the competition results reveal that in the Junior Competition (Grades 8 and 9), there were only three females out of sixteen going through to the third round of the competition. At the Senior level (Grades 10, 11 and 12) the situation is very similar, with 26 females of 140 candidates going through to the third round of the competition (source: results sent to the schools). Visser (1987) also found that there were no overall differences in performance among early adolescents and adolescents, in particular there were no overall differences at the end of Standard 10 (Grade 12), although at the upper end of the scale, she found that there were "substantial differences in relative preponderance in favour of males" (p. 142). It should also be noted that often these differences are very small and that the differences within a group or between cultures are much greater than the differences between the gender groups.

Spatial visualisation

Spatial visualisation, as a concept, has been identified as a possible contributing factor to the observed gender differences in performance. Spatial visualisation is just one part of a more general group of spatial skills needed to perform certain mathematical tasks. Tartre (1990) defined spatial visualisation as "the skill of mentally manipulating all or part of an object" (p. 29). There are two sub-categories of spatial visualisation - mental rotation and mental transformation. The second spatial skill identified by Tartre (1990) is that of spatial orientation which "includes the comprehension of the arrangement of elements within a visual stimulus pattern, the aptitude to remain unconfused by the changing orientation in which a spatial configuration may be presented, and an ability to determine spatial orientation with respect to one's own body" (p. 33-34).

It has been found that even when no overall gender differences in performance are observed, differences in spatial skills have been found. In fact, Tartre found that "(t)he conjecture that higher spatial skill (either spatial visualisation or spatial orientation) for males contributed to their better achievement in mathematics was not supported by these studies." (1990, p. 57) In addition, it was found that on occasion males with low spatial skills scored higher on tests of mathematical ability than males with high spatial skills. Spatial skill level is more related to performance in mathematics for females than for males (Tartre, 1990). Armstrong (1981) concluded that her studies did not support "the hypothesis that males' superior achievement in mathematics is due to a superior ability in spatial visualisation" (p. 369). It has been shown that males are superior in spatial ability (Scott-Hodgetts, 1986; Battista, 1990; Hyde, et al., 1990). The use of spatial skills is not always required in problem solving but rather it is specific to the type of problem being solved. Since spatial ability can be improved by training (Rowe, 1988 cited in Grouws, 1992), this aspect of 'inferiority' among females need not be an insurmountable barrier to improved problem solving skills. A verbal-logical approach to problem solving can often be more effective than presenting mathematical information in a visual way. Learners who have different levels of spatial visualisation and verbal skills use different processes to solve problems. Differences in these skills (eg. low spatial, high verbal or high spatial, low verbal) does not result in a differing ability to solve problems (Fennema and Tartre, 1985). Tartre (1990) concluded that

> females who scored high on a test of spatial skill achieved as well as, and in some cases much better than, the male groups on mathematics achievement and measures of many other strategic variables. However, females who scored low on a test of spatial skill experienced difficulty in accomplishing many tasks involved in solving mathematics problems. They needed more help more often than others and yet, when they received assistance, were not very successful in making use of it. They

> did not appear to be able to draw upon other skills to compensate as were low-spatial males. (Tartre, 1990, p. 57)

Battista (1990) reported that males were more likely to "use a visualisation strategy and the less likely to use a drawing strategy" (p. 57) when the discrepancy of spatial visualisation over logical reasoning is greater. It was suggested that the reason is that males with a higher spatial ability tend to think that drawings are unnecessary, thus would rather use visualisation strategies (Battista, 1990). In the same study it was found that the reverse was true for females. Visser (1987) found that there were no gender differences in spatial visualisation at the Standard 5 (Grade 7) level, whereas significant differences favouring males were found at the Standard 7 (Grade 9) level. It was also found that there exists a correlation between spatial abilities and achievement within the sample studied (Visser, 1987). It has also been found that research into spatial skills yielded very inconsistent results - there is no conclusive evidence of what role spatial skills actually played in gender differences (Fennema and Carpenter, 1981; Shuard, 1982).

Overview of gender related differences in performance

It is important to remember that when gender related differences in performance appear, they are often very small and they seem to be concentrated in certain types of problems. Many results in the literature proclaim differences in performance which are *statistically significant*. Such results need to be interpreted with caution, since statistically significant results can in reality be very small and *educationally insignificant*. It is the power of the statistical tests used that tends to highlight deceptively small differences (Walkerdine, 1989). It seems that males tend to perform better on higher cognitive level tasks and females tend to perform better on the lower cognitive level tasks (Frost, et al., 1994; Fennema and Carpenter, 1981). Stage, Kreinberg, Eccles, and Becker drew the following three conclusions regarding gender differences in mathematics achievement:

> (1) high school boys perform a little better than high school girls on a test of mathematical reasoning (primarily solving word problems); (2) boys and girls perform similarly on tests of algebra and basic mathematical reasoning; and (3) girls occasionally outperform boys on tests of computational skills.
>
> (cited in Frost, et al. 1994, p. 374)

It has been found that females outperform males in computational skills (Frost, et al., 1994; Hyde, et al., 1990; Scott-Hodgetts, 1986; Ethington, 1990; Armstrong, 1981). Males were found to excel, and thus outperform females, in the areas of:

- problem solving (Frost, et al., 1994; Hyde, et al., 1990, Scott-Hodgetts, 1986; Schonberger, 1978; Taylor, Leder, Pollard and Atkins, 1996; Armstrong, 1981);
- geometry (Frost, et al., 1994; Hyde, et al., 1990; Scott-Hodgetts, 1986; Opyene-Eluk and Opolot-Okurut, 1995; Battista, 1990; Ethington, 1990; Taylor, et al., 1996; Hanna, 1986);
- ratio (Opyene-Eluk and Opolot-Okurut, 1995; Seegers and Boekaerts, 1996; Taylor, et al., 1996);
- measuring and fractions (Ethington, 1990; Seegers and Boekaerts, 1996; Hanna, 1986);
- probability, spatial reasoning and mechanics (Taylor, et al., 1996).

No gender differences were found in arithmetic, algebra and in the understanding of mathematical concepts (Frost, et al., 1994; Hyde, et al., 1990). Ethington (1990), however, reported that females were found to perform better on items "involving more abstract reasoning such as the algebra of sets (Wood, 1976) and problems involving the construction and analysis of symbolic relationships (Pattison and Grieve, 1984)." (p. 74-75)

Problem solving

Hyde, et al. (1990) found that at the elementary and middle school level, there was a slight female superiority in problem solving and that this pattern is reversed in favour of males in the high school and college groups. Seegers and Boekaerts (1996) found that gender differences in performance increase with the complexity of the item. "The items of lowest complexity did not differentiate between boys and girls ... although boys scored significantly higher on the middle-level items ... as well as on the most difficult items." (Seegers and Boekaerts, 1996, p. 228) In a study on problem solving skills, Schonberger (1978) cites results from Leder (1974) where she used "mathematically parallel pairs of problems with stereotypical male and female settings. Tenth grade boys and girls preferred the problems appropriate to their traditional sex-roles." (Schonberger, 1978, p. 25).

In the Cockcroft Report, as quoted by Opyene-Eluk and Opolot-Okurut (1995), Wood concluded that for the items in which girls outperform boys, problem solving skills were not generally required, but rather skills that were predisposed to drilling, for example "recognition or classification, the supplying of definitions, applications of techniques, substitution of numbers in algebraic expressions and so forth." (p. 874) Another factor identified by Grieb and Easley (cited by Fennema, 1990) that tends to promote the development of problem solving skills among boys is that boys "have a distinct advantage over ... girls with similar mathematical creativity: they can develop habits of independent thinking in mathematics from early primary grades because they are not being expected by most teachers to conform to the social norms of arithmetic" (Fennema, 1990, p. 175). It is apparent from this argument that girls tend to do what the teachers have asked them to do - they must be neat, their work must be complete and accurate, which often results in methods that tend to encourage rote learning. The boys on the other hand tend to be busier developing their problem solving skills and working independently.

Multiple choice questions

Marshall (1983) performed an analysis of distracter choices in multiple-choice question papers in order to determine the different types of errors made by males and females. It was found in this study that girls were more likely than boys to make errors in confusion of meaning, misuse spatial information that had been given, make errors in reading scales, errors of negative transfer (i.e. perform operations with no regard for the context of the problem) and key word association. On the other hand, boys were more likely than girls to make errors in the translation of a problem, in the choice of operation and formula interference. Furthermore, Marshall found that "(b)oth sexes make language-related errors, but these errors are not the same." (Marshall, 1983, p 334). Hanna (1986) found that on a multiple choice type test, girls tended to omit more questions, rather than guess an answer, than the boys. These differences were found to be significant at the 0.01 level. She found that the omission rates in the ratio of boys to girls were 2 to 3 - i.e. one and a half times as many girls as boys were omitting questions (regardless of the topic) (Hanna, 1986).

Schools

Some research has been done into whether the type of school which a student attends affects gender related performance in mathematics. In France schooling has been based on a traditionally segregated system until recently. There has been a strong move towards the coeducational system of education in more recent times which has resulted in disastrous consequences for the number of women studying mathematics. It seems that the boys are more comfortable in a competitive atmosphere found in preparation classes for the ENS's (Écoles Normales Supérieures). As a result the merging of the ENS's has made the path for women into further study in mathematics a lot more difficult (Delon, 1995).

Opyene-Eluk and Opolot-Okurut (1995) found that in Uganda there was a significant difference in mathematical achievements of pupils from mixed and single-sex schools, in favour of pupils from single-sex schools. In order of levels of achievement, it was found that boys from boys-only schools were the top performers, followed by girls from girls-only schools. Girls from mixed schools were found to perform worst. It is however noteworthy that overall there were no significant differences in achievement; in particular there were no significant differences between the boys from mixed schools and girls from girls-only schools in mathematics achievement.

In Malawi, a Ministry of Education affirmative action policy is in place which reserves a third of the places in secondary schools for girls. As a result girls are allowed to enter the secondary phase with lower scores than are required by the entrance requirements. The situation is mirrored in the tertiary phase, in that tertiary institutions have allowed girls with lower Malawi Certificate of Education (MCE) scores to be admitted for further study. Students from girls-only schools have met with far greater success than their counterparts from the coeducational schools. Gender related differences in mathematics achievement have followed the general pattern of boys outperforming girls in the secondary phase (occurring in all subject areas, not just mathematics). At the first-year university level though, it has been observed that females' performance in mathematics shows a substantial improvement relative to that of the males. The performance of girls in Malawi (and Kenya) seems to contrast with that of girls in developed countries. In Malawi and Kenya, girls appear to outperform boys in the higher levels of tertiary education, whereas in the developed world, boys outperform girls from early adolescence and this pattern continues into the later years. (Hiddleston, 1995)

Culture

The culture of a society is an important factor which should be taken into account when analysing gender related differences in mathematical achievement.

> (G)ender differences ... stem from cultural pressures and socialisation processes characteristic of many countries in which females are not permitted to develop their mathematical abilities to their fullest potential. ... Such cultural stereotypes not only include the alleged natural superiority of boys' mathematical abilities, but also differences in beliefs about the utility of the discipline for boys and girls.
>
> (Kaely, 1995, p 91)

Developed/Developing countries

In developed countries, as the role of women improves, the gender related differences in performance decrease, while at the upper levels of performance differences have remained relatively constant. In developing countries, the situation is more complex.

It has been found that even in some regions within a male-dominated society (eg. in India) there exists female dominance in mathematics (in the Mangalore region of Mysore State) (Kaely, 1995). In matrilineal societies, it is found that girls are respected more in the classroom as well as in society. In such societies it is reported that "females exhibit equal, if not better performance in mathematics compared with males." (Kaely, 1995, p. 95)

In terms of enrolment in advanced mathematics courses, in developed countries there are two or three times as many males as females enrolled. In developing countries the reason for the lower number of girls enrolled in academic institutions stems from the cultural norms of the society - if a family can only afford to send one child to school, it will normally be the male since he is considered to be a future bread-winner. (Kaely, 1995)

In many non-Western, developing countries illiteracy is more of a national problem than the inequity in gender performance in mathematics and it is only after the problem of illiteracy is addressed that resources can "be devoted to the more subtle issues such as the reform of the male-oriented primary and secondary-school mathematics curriculum." (Habibullah, 1995, p. 127) For religious and cultural reasons in some non-Western countries, schooling is based on gender-segregated education. It is reported that girls in these girls-only classes experiencing a greater sense of self-confidence and freedom of expression, free from feeling intimidated by the presence of boys, who are naturally more assertive than girls, in a coeducational classroom (Habibullah, 1995).

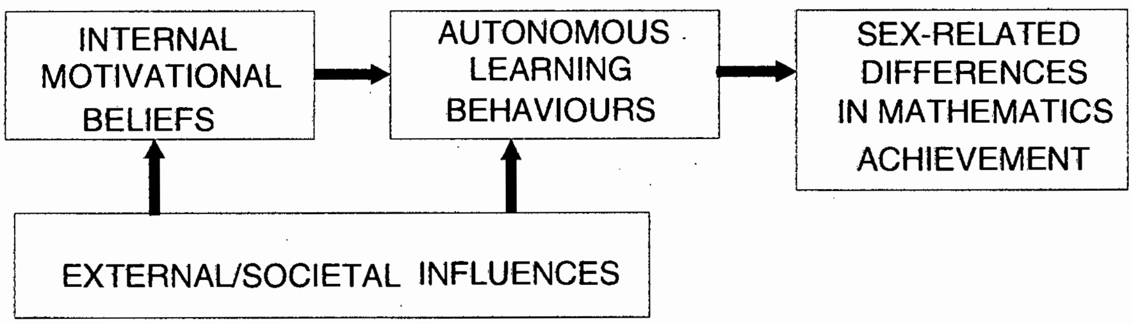
In the experience of people in Papua New Guinea, a girl has a better chance of receiving an education if both her parents are educated. Again in such a country, if money is scarce, a son would be educated before a daughter. A son would receive a very good quality international education, whereas a daughter would attend a local ("inferior") school, and since education is not included in her "price" within the marriage system, it is not important for her to receive a good education (Sukthankar, 1995). Aside from the cultural differences (also a strong influence in South African society) the language in which the learners are taught emerged as a problem. In Papua New Guinea, mathematics is taught in English which is often only the second or even third language of the learners, resulting in the translation of the stated problem in English into some form of mathematical language being very difficult. It has been observed that although the learners have the ability to complete a mathematical problem once it has been translated, it is the translation that forms the barrier, as many English concepts are very unfamiliar to Papua New Guineans (Sukthankar, 1995). In the South African society, many learners are not taught in their home language, which clearly causes problems in that some concepts within mathematics are very unfamiliar when translated from English into their own language.

Autonomous Learning Behaviours Model

In an attempt to explain the differential performance of males and females in mathematics, Fennema and Peterson (1985) proposed the model of Autonomous Learning Behaviours (ALB). Meyer and Schatz Koehler (1990) have the following to say about this model:

> A student who is autonomous is one who increasingly assumes control of the learning process. The student *chooses* to engage in high-level mathematical tasks and prefers to *work independently* on them. When a task proves to be difficult, the autonomous learner *persists* with the task.
>
> (Meyer and Schatz Koehler, 1990, p. 69)

The Autonomous Learning Behaviours Model is presented in the following form:



(Fennema and Peterson, 1985)

Fennema and Peterson (1985) relate the ALB to the completion of tasks of high cognitive complexity:

> To do tasks of such complexity, one must be able to work independently, persist, choose, and succeed at such tasks. These behaviours, autonomous learning behaviours (ALB), are hypothesized to serve as mediators between internal/external influences and mathematics performance in tasks of high cognitive complexity where sex-related differences in mathematics are found. ALB are developed over a period of years and are learned as one is allowed, forced, or expected to do them. Greater participation in ALB leads to greater development of ALB

> which in turn leads to better performance on high cognitive level tasks.
>
> (Fennema and Peterson, 1985, p. 309)

Factors which affect the development of ALB's include the confidence level of the learner, a facilitative attributional style and a perception of gender-role congruency. By a facilitative attributional style, it is meant that success should be attributed to ability and effort whereas failure is attributed to unstable factors such as task difficulty or luck (Meyer and Schatz Koehler, 1990). External influences include the classroom environment and interaction of the teacher with the learner, since "differential classroom experiences influence the development of one's internal motivational beliefs, and/or directly influence the participation in ALB." (Fennema and Peterson, 1985, p. 311)

In the preceding review of the literature pertaining to differential achievement in mathematics, it is seen that there seems to be a variety of influences affecting performance in mathematics. Ethington and Wolfle (1984) came to the following conclusions:

> The present research suggests once again that a great deal of the difference in mathematics achievement between men and women can be explained by differences in background, ability, attitudes, grades, and formal exposure to mathematics in the classroom. Of these, the variables measuring exposure to mathematics had the most influence on explaining variation in mathematics achievement.
>
> (cited in Grouws, 1992, p. 608)

Gender related differences in attitudes towards mathematics

Public image

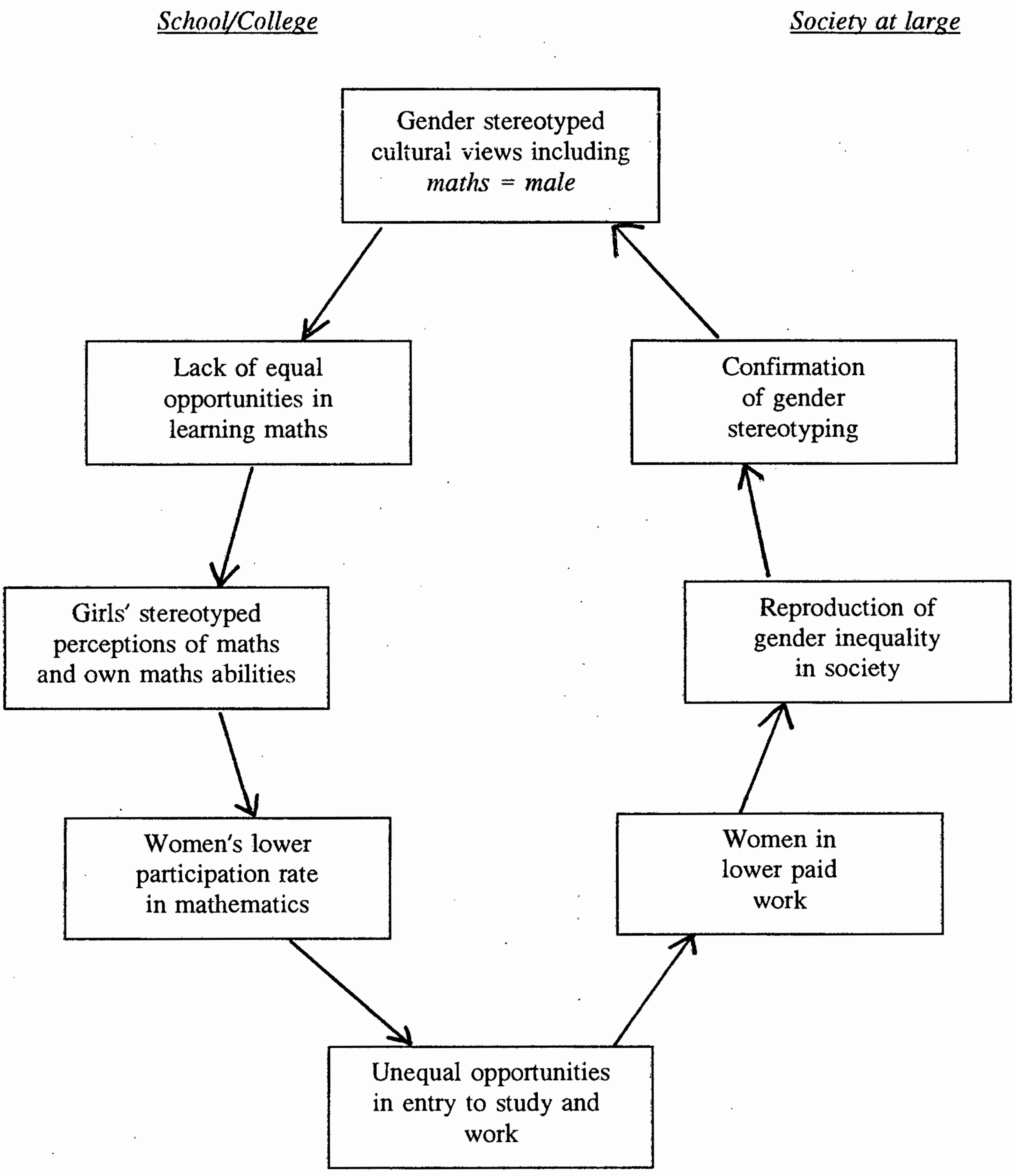
The image that mathematics portrays is an important influence on a learner's attitudes towards the subject and towards their participation in the subject. According to Ernest (1995), the public image of mathematics is that it is cold, difficult, abstract, theoretical, ultra-rational and important and especially <u>male</u>. It is also seen as remote and inaccessible to most. Sells has been cited by Ernest (1995) as claiming that "(m)athematics serves as a 'critical filter' controlling access to many areas of advanced study and better-paid and more fulfilling professional occupations." (Ernest, 1995, p. 450). As such, it is surely important that access to and performance in mathematics should not be impeded by negative attitudes and views on the subject. Clearly, though, this is not the case as it has generally been found that males hold more positive attitudes towards mathematics than do females and also that females tend to 'drop out' of mathematics at a much faster rate than males. In this section, I will try to cover as many aspects pertaining to gender related differences in attitudes towards mathematics as possible.

Mathematics as a male domain

From the above, it is clear that stereotyping the subject as a male domain is critical in how its learners' attitudes are developed. Since no learner exists in a vacuum, the attitudes of his or her teachers, school, parents and the society as a whole will impact on the development of his or her attitudes towards mathematics. It is in the area of "mathematics as a male domain" that this influence is so readily observed. From the research, it is clear that males stereotype mathematics as a male domain more strongly than do females (Frost, et al., 1994; Isaacson, 1986; Opyene-Eluk and Opolot-Okurut, 1995; Fennema and Sherman, 1977; Sherman and Fennema, 1977; Ernest, 1995; Visser, 1987; Fennema, 1978; Meyer and Schatz Koehler, 1990). Meyer and Schatz Koehler (1990) point out that stereotyping mathematics as a male domain is an important influence on the valuation of mathematics by females - "If she believes mathematics is inappropriate for females, then her achievement in mathematics could result in a perception that she has not adequately fulfilled her sex-role." (Meyer and Schatz Koehler, 1990, p. 63).

Owing to the males' more stereotyped attitudes, females may be influenced in their mathematics-related endeavours and could be discouraged from achieving in and further participating in mathematics (Frost, et al., 1994). It is not always the case that girls who are good at mathematics continue studying the subject and other mathematics-related courses (for example, science). Often it is the case that these talented girls opt out of mathematics because of the masculine image of the subjects and the careers to which such subjects lead. In girls-only schools, girls more readily opt for the "masculine" subjects since their femininity is not under threat (Isaacson, 1986). Isaacson also makes the following interesting observation that "(i)t may be the case that more boys than girls achieve well in mathematics because they are less free than the girls to reject it and pursue other studies rather than because girls are less free than boys to choose it!" (Isaacson, 1986, p. 239). Opyene-Eluk and Opolot-Okurut (1995) reported that in single-sex schools there is a more serious study environment, more time to spend on homework, an absence of teachers' gender-related expectations for success and there is not as much peer pressure. As a result it seems that both boys and girls from single-sex schools tend to perform better than their counterparts from mixed schools.

It is clear that parents, teachers and society on the whole can serve to reinforce and perpetuate the gender-stereotyping of mathematics as a male domain. Ernest (1995) proposed a reproductive cycle of gender inequity in education resulting from gender-stereotyping mathematics as a male domain in the following diagram:



(Ernest, 1995, p. 457)

Culture

It has been observed in the survey of the literature pertaining to gender related differences in mathematics that culture and societal influences play an important role in the perpetuation of such differences. In a similar way, the dominating culture plays an important role in the perpetuation of stereotyping mathematics as a male domain (Kaely, 1995). In many countries, the females are disadvantaged in that the development of their mathematical abilities is impeded by cultural and social influences, whereas the males are believed to be superior in their ability in mathematics (Kaely, 1995). Naturally, an important influence will also be the extent to which the society believes that mathematics is useful to the learner.

Parents

Parents are also important influences on a student's perception of mathematics. For example, parents have differing career aspirations for their sons and daughters: parents would like their sons to have good prospects and security for a career, whereas their aspirations for their daughters are that their careers should be their own preference and their work should be "interesting" (Kelly, 1986). The implication is that the boys should become the providers and that the girls' work is considered less serious or important. It is ironic that parents often express strong views on equality and equity in education and yet within the home gender-typed roles are still perpetuated (Kelly, 1986).

School and timetabling

The structure of the school plays a large part in the reinforcement of gender-role stereotyping. The overriding factor is that of the timetabling of subjects, as this is what determines which subjects a learner will follow during his/her school career and ultimately affects the choice of career. The timetabling of "girls' " subjects opposite "boys' " subjects (for example, home economics against woodwork) is damaging in that it leads to "different achievement levels in cognitive skills useful for learners of mathematics and science" (Isaacson, 1986, p. 229). Even though in some (all?) schools the subject choice is supposed to be free to the extent that boys and girls are theoretically not limited to "their" subject groups, the structure of the rest of the timetable (for example, if a girl wanted to take woodwork it often meant that she would be in a "boys" class, meaning that she would have to do physical education with the boys) often puts much pressure on the students to remain solely within their traditional subjects. In the single-sex schools, girls are not even given the option of taking woodwork or any other traditionally male subject. One advantage of being in a girls-only school is that girls do not have the same pressure as could be experienced in a co-educational school, essentially causing them not to take or participate more actively within the stereotypically male subjects of mathematics and physical science.

Confidence

It has been found that a further factor affecting learners' overall attitude towards mathematics is their confidence in their ability to learn the subject. Confidence is that affective variable which influences a student's willingness to approach new work and whether he or she will persist if the subject is not easily learnt; it is reflected by continued participation in mathematics and the career choices made by the student

(Meyer and Schatz Koehler, 1990). It has been found that males tend to have much higher confidence levels than females (Seegers and Boekaerts, 1996; Fennema and Sherman, 1977; Opyene-Eluk and Opolot-Okurut, 1995; Leder, 1990; Meyer and Schatz Koehler, 1990; Visser, 1987). It has also been found that gender differences in confidence levels persist even when there is no gender-related difference in performance (Meyer and Schatz Koehler, 1990; Seegers and Boekaerts, 1996). Hart (1989) found that confidence has a significant positive correlation with achievement: if there was a gender-related difference in favour of males in achievement, then a gender-related difference in favour of males was observed for confidence levels. Opyene-Eluk and Opolot-Okurut (1995) report that Ugandan school children still demonstrate "mathephobia" (an "irrational and impeditive (sic) dread of mathematics" [Lazarus, cited by Maxwell, 1989, p. 221]) and their female students especially lack confidence which could possibly cause a cognitive block towards solving mathematical problems, resulting in the present tendency for females to opt out of mathematics at a faster rate than the males do. Students who have high confidence levels have been observed to engage in mathematics for a longer period of time than low-confidence students (Hart, 1989). An important and interesting observation in the same study was that no statistically significant difference by gender or by confidence level of the student was found in the engagement of the student in high-level activities. Teacher-student interactions were measured by a modification of the Brophy-Good Dyadic Observation System. This result differs from the expectation that boys would spend more time on high-level tasks and girls would spend more time on low-level tasks (Hart, 1989).

Fear of success

A further construct that has been referred to in the literature is that of "fear of success", which was first identified by Horner in 1968. This fear of success

> describes the conflict, resulting fear, and decreased performance that many women experience because of the clash they perceive between attaining success and fulfilling the female role in our society. Fear of success is the fear of the negative consequences that accompany success.
> (Meyer and Schatz Koehler, 1990, p. 65)

Two sources of these negative consequences were identified as being "(1) individual's loss of her sense of femininity and self-esteem and (2) social rejection because of success" (Meyer and Schatz Koehler, 1990, p. 65). Leder (1982) drew the following conclusions from her research into this construct:

> From the findings obtained it appears that girls who perform well in mathematics are more likely to be high in FS [fear of success] and yet that, for some, high FS tends to be incompatible with continued high performance in mathematics. Possibly some of the girls high in FS resolve their conflict situation by either opting out of intensive mathematics studies or by lowering their performance and thus no longer continuing to be conspicuously successful. (Leder, 1982, p. 133)

Even though I will not be investigating this construct in this research, it is mentioned since I believe that it plays an important role in the developing of attitudes towards mathematics and also plays an important role in the performance of females in mathematics.

Motivation

Leder (1986) identified the following with regard to motivation to achieve in mathematics:

> Variables that typically aroused achievement motivation in males frequently failed to do so for females. For example, cues that stressed leadership and intelligence qualities aroused optimal achievement efforts in males but did not necessarily have the same effect on females. The

> latter frequently responded more positively to situations that concerned approval and affection from others. (p. 82)

Intimately connected within the area of motivation is the fact that males seem to thrive in an environment in which interpersonal competition is encouraged; thus a competitive classroom atmosphere is more conducive to academic achievement in males than in females (Seegers and Boekaerts, 1996). It is only in more recent years that co-operative learning is being encouraged at the school level, which could then be a means of enhancing the learning situation for females in this country.

Usefulness

If a student does not perceive that a subject is useful to him/her, that student's attitude towards the subject could be adversely affected. It seems to be a general conclusion that males tend to perceive mathematics as being more useful to them than do females (Frost, et al., 1994; Kelly, 1986; Visser, 1987; Meyer and Schatz Koehler, 1990). Perception of usefulness of mathematics is also strongly connected to participation and achievement in the subject. Once again parents, teachers and society as a whole can (and do!) affect a student's perception of the usefulness of mathematics since their opinions are very closely connected to their own stereotyped views of the subject. Since the dominant view of mathematics is that it is a "male" subject and because the careers to which it leads are also stereotyped as male, it is not surprising that many parents and teachers convey to the students the opinion that mathematics is more useful to males than it is to females (Kelly, 1986).

Good and bad experiences

In a study by Hoyles (1982) it was observed that when children related stories about good and bad classroom experiences, over half of the stories about mathematics were "bad" (that is, they had negative experiences in the mathematics classroom). In mathematics, satisfaction in the subject was attributed to involvement of success in the work, whereas dissatisfaction was blamed on the teacher. The pupils seemed to be very concerned about their "own role in relation to [their] mathematical learning and in particular whether he or she can 'cope' with the work or have some control over what is going on" (Hart, 1982, p. 361). Of the "bad" stories, the greater percentage of the negative feelings were about the self - bad experiences were associated with feelings of hopelessness, anxiety or shame; often feelings of lack of confidence and inadequacy were expressed. These feelings were heightened by stress induced by an excessive workload or public humiliation, resulting in an adverse effect on the pupil's confidence. A further factor that can have a negative effect on a pupil's confidence is pressure imposed by the teacher and the pace at which the work is tackled (Hoyles, 1982).

Coercive inducement and double conformity

In an attempt to provide an explanation for differences in achievement, Isaacson (1989) introduced the notions of "coercive inducement" and "double conformity". Coercive inducement is easily explained in the context of the roles girls choose: girls tend to choose appropriately feminine roles, but these roles are not necessarily chosen with a 'free' will but are " 'chosen' because of a system of rewards and approvals which act as inducements and which are so powerful that they come to be a kind of coercion" (Isaacson, 1989, p. 188). From an early age, mathematics is seen as "male" and is linked to other technical subjects. Even if girls do not drop out of mathematics, they tend to become disengaged from the tasks; in a way they are "dropping out" within the class, resulting in their marks and performance being adversely affected. The second idea is that of double conformity which "concerns strict adherence on the part of both educators and educated to two sets of rigid standards: those of ladylike behaviour at all times and those of the dominant male cultural and educational system" (Delamont cited by Isaacson, 1989, p. 191). Women who have chosen stereotypical male subjects are expected to conform to two sets of mutually exclusive standards - behaving like a lady and active participation in competition in a male world with rules based on a male standard.

Personality variables

Finally, attitude towards mathematics and achievement in mathematics are significantly related to personality variables that encourage good adjustment. Some of these personality variables include:

> high sense of personal worth, a greater sense of responsibility, high social standards, high academic achievement motivation and a greater freedom from withdrawing techniques. Furthermore, children with positive attitudes towards mathematics tend to like detailed work, to view themselves as more persevering and self-confident ... and to be more "intuitive" than "sensing" in their personality type. (Aiken, 1976, p. 297)

Relationship between attitude and achievement in mathematics

In their meta-analysis, Ma and Kishor (1997) integrated the results of a number of studies in which a relationship between attitudes towards mathematics and achievement in mathematics was investigated. A conclusion drawn in this study was that gender did not affect the relationship between attitude and achievement in mathematics. It was also found that

> the junior high grades may be the most important period of schooling for students to understand and shape their ATM [attitudes towards mathematics] as it relates to AIM [achievement in mathematics]. During the senior high school years, students may hold more fixed or stable ATM that tends to affect less or be less affected by AIM.
>
> (Ma and Kishor, 1997, p. 41)

Toy manufacturers also play their part in perpetuating a stereotyped image of mathematics. In 1992, the manufacturers of the "Barbie" doll produced a new doll that could talk. One of the sentences that Barbie says is

Math class is tough!

METHODOLOGY

Process of setting the question papers

The process of setting the annual University of Cape Town Mathematics Competition begins in about July of the previous year, when the members of the Problems Committee (of which I have been a member for the last four years) submit problems which could possibly be used in the competition. Questions are often adapted or even used in their original form from other Mathematics Competitions from around the world. In particular, questions from the Australian Mathematics Competition are very useful since the statistics are readily available in their annual report on their Competition. The University of Cape Town Mathematics Competition is actually very closely modelled on the Australian Mathematics Competition in terms of the structure of the question papers. The eight committee members are made up of school teachers (who are familiar with the syllabus content and thus can provide advice about the content of specific problems) and members of the Mathematics Department at the University of Cape Town.

The full set of problems is distributed to the members of the Problems Committee in order for the grading of the problems to be completed. The grading of the problems involves each member of the Problems Committee deciding on the suitability of each question (rejecting the question if it is too difficult or based on syllabus content that has not yet been covered within that grade), for each grade. The level of difficulty within each grade must also be decided upon. Once the grading of the problems has been collated and analysed, the Problems Committee meets in order to decide which questions should be included in the upcoming Competition. It was at these meetings where I requested that particular questions be included in one or more of the papers, enabling the responses of a large sample to be tested and analysed.

Five question papers are set, one for each grade. The structure of each question paper involves three distinct sections: the first ten questions are the easiest, the next ten questions are of "medium" difficulty, with the last ten questions being classified as difficult. Typically the last five questions on each question paper are the most difficult and serve the purpose of ranking the top candidates in each grade. The scoring of the questions is as follows:

Question number	Wrong answer	No answer	Correct answer
1-10	0	1	4
11-20	0	1	5
21-30	0	1	6

The question papers are marked and the candidates are ranked using the UCT MCQ computer programme. This programme allows the candidates to be split into quintiles, based on their relative performance in the competition. The data which will be analysed is that obtained from the 1997 University of Cape Town Mathematics Competition.

Categorisation

The questions used in the papers were then categorised using the definitions provided by Taylor, et al. (1996). The categories of Arithmetic, Algebra, Geometry and Problem Solving enabled all the questions to be categorised. These categories were further split into the "Mutually Exclusive" Categories where each area, with the exception of the Problem Solving Category, comprised a "Basic" and a "Routine" section depending on the nature of the problem. The Problem Solving Category was split into Routine and

Nonroutine Problem Solving, where the Routine Problem Solving included those questions which could readily be solved using methods that had been taught in class. The Nonroutine Problem Solving included those questions which required the candidates to use innovative and "new" techniques to solve the problems. Aside from these Mutually Exclusive Categories, those questions which could be placed into one of the "Special Categories" received a further classification. Full details of this classification are given in Chapter 3 (Analysis and Discussion: Performance).

Sample

The University of Cape Town Mathematics Competition has two components: the individual competition and the pairs competition. In this study, only the data from the individual competition will be analysed. The reason for this is that it is only in the individual competition that the candidates give any indication of their gender. In the pairs competition, the pair may consist of only one gender or may be a combination of both genders. In the case of the "mixed" pairs, it is not obvious which partner was dominant; thus the statistics could be difficult to interpret..

Thus the sample is not necessarily representative of the entire school-going population in the Western Cape Province of South Africa, since not all schools enter their pupils in the University of Cape Town Mathematics Competition. It is, however, fairly representative of a wide range of abilities in mathematics. A comparison between the performance of the individuals and the pairs is given in Appendix A, in the item analysis provided.

Since the data obtained would be better analysed using quantitative methods, the analysis of the data was done using the computer programme STATISTICA (obtained from the University of Cape Town Computer Science Library). The totals of the individual participants for each of the component categories were calculated within each grade, as well as the overall total for the competition. It is these totals that will be compared as detailed in the following sections.

Analysis: Performance

t-tests for Independent Samples

The main focus of this study is to detect differences in the means of the two samples (males and females) within each grade on each of the categories. Thus the test that is most commonly used to detect such differences between independent samples is the *t-test.* In this study, the *t-test* with separate variance estimates has been used since the *t-test* computed in the ordinary way may not accurately reflect the statistical significance of the difference if the variances within each group are very different and the number of observations in each group is not the same. Connected with each *t-statistic* is the associated *p*-level. This *p*-level represents the probability of error involved in accepting, on the basis of the sample in question, the hypothesis that these differences actually do exist between the genders, when in fact there are none. Thus the smaller the *p*-level, the more statistically significant is the difference inferred. It is however expected that 5% (1%) of all (mutually independent) *t-statistics*, or ANOVA F-statistics, will achieve 5% (1%) significance, even in the absence of differences. In order to infer presence of some possible differences when examining multiplicities of statistics, a large number of statistics that are statistically significant at 5% (1%) are required. When making unrestricted use of comparisons among groups, an excessively high probability of making a Type I error (rejecting the null hypothesis when it is in fact true) is reached.

In an attempt to control this error, a **protected t-test** or Fisher's **least significant difference test** can be performed (Howell, 1989).

Analysis of Variance (ANOVA)

In the same way that the *t-test* has the purpose of detecting significant differences between the means of two independent samples, analysis of variance is also a test designed to detect significant differences between two or more means. If there are only two groups being tested then analysis of variance will produce identical results to those produced by the *t-test*. The analysis of variance is a test which compares the two variances in order to detect any statistical significance between the means. There are two sources of variance: the variance due to random error (i.e. within-group sum of (deviation) squares) and the variance due to differences between the means. These variances are estimated by summing the squares of the deviations (SS) from the overall group means, partitioning the SS and dividing by the corresponding degrees of freedom (df). If the ANOVA tests detect statistical significance in these two estimated variance components then we can conclude that these differences do exist between the groups. One of the advantages of using analysis of variance is that it allows us to detect interaction effects between constituent explanatory factors.

For the purposes of this study, two different analysis of variance tests will be described. The one-way analysis of variance is designed to test for differences between the means of a number of independent groups being tested on the same or standardised question. The second test to be used is the two-way analysis of variance, which allows for more than one between groups factor. In this study the two factors are year (i.e., grade) and gender.

In this study, the analysis of variance will be used to analyse the results of those individual questions that appeared in more than one question paper. Three different analysis of variance tests will be performed on the data:

- In order to detect any possible differences between the genders, a one-way ANOVA will be performed (this particular analysis could have been done using a *t-test* for independent samples since there were only two groups being tested).
- A one-way ANOVA will be performed on the data in order to detect any possible differences between the grades in which the particular question was tested. Such a test will indicate whether the candidates' performance (regardless of gender) shows improvement with maturity in mathematical ability and knowledge of problem solving techniques.
- It is also of interest to determine the interaction effects of both maturity in mathematics and gender on performance in a particular question. Thus a two-way ANOVA will be performed on the data using grade and gender as the two explanatory variables and the score on the item as the dependent variable.

Quintile Analysis

The relative number of males and females in each quintile will be analysed. The quintiles in each grade are determined by ranking candidates' scores in that particular grade and dividing them into five equal groups. Conclusions can then be drawn about the relative positioning of males and females at each level of the ability scales represented in the University of Cape Town Mathematics Competition. (see page 56)

Attitudes Questionnaire

After careful review of the literature, it became clear that the Fennema-Sherman Attitudes Scales are very widely used as an instrument to determine the attitudes of students. As a result of making contact with Dr. L.S. Cronjé (University of the Witwatersrand), I received a copy of the questionnaire she had used for a similar purpose. The questionnaire had been adapted from the original Fennema-Sherman Attitudes Scales for use in the South African context by Visser (Visser, 1985). I extracted sixteen of the items for use in the questionnaire for this study. Some of the items were re-worded to ensure a better understanding of the content by the candidates. The items selected reflected four main attitudinal areas: motivation, confidence, usefulness of mathematics and mathematics as a male domain.

Analysis: Attitudes

The aim of the 16-item questionnaire was to determine if there were any statistically significant differences in attitude between the genders. In order to determine this, *t-tests* were performed on each item and these results analysed. I also wanted to determine which, if any, of the attitudes/items were related to the overall outcome on the competition. This exploration was done by examining the correlation coefficients between the responses on each item and the total score of each candidate.

Pearson product-moment correlation coefficient

A correlation coefficient determines the strength of the direct linear relationship between two variables. The correlation coefficient that was determined in this study is the Pearson product moment correlation coefficient. This correlation determines the extent to which the relationship between the two variables can be represented by a linear relationship. The range of the value of the correlation coefficient, r, is given by $-1 \leq r \leq 1$. The significance level of the correlation coefficient is dependent on the sample size.

In this study, the correlation coefficients of item with total score was calculated for each gender within each grade. These results were compared within each gender, across the grades in order to determine the existence of any patterns in the data related to school grade.

RESULTS AND DISCUSSION: PERFORMANCE

For the purposes of this research, a multi-faceted approach to the analysis has been used. It was of interest to investigate a number of different aspects using the available data, looking at any possible differences in performance in a number of areas or categories. The categories become more specialised as the analysis progresses, until eventually specific competition questions are investigated, in particular those questions that appeared in more than one paper. The question papers in their original form are presented in Addendum A.

It is also of interest to examine some raw data regarding the relative performance of males and females in the University of Cape Town Mathematics Competition. The following two tables detail the numbers of each gender participating in the competition and the difference in the mean number of correct responses, wrong responses and omitted responses.

Table 1 Participation in the competition

Grade	Males	Females
8	146	157
9	141	175
10	179	167
11	181	166
12	199	165

The University of Cape Town Mathematics Competition is open to all schools within a 200km radius of Cape Town and the number of candidates that each is school is permitted to enter is limited to five learners in each grade to take part in the "individual" competition, as well as four pairs per grade to take part in the "pairs" section of the competition. As previously stated (p. 32), only the data obtained from the "individual" competition was analysed. Thus Table 1 is only the number of entrants in the "individual" competition. It is also clear from the table that in Grades 8 and 9 the number of females outnumbered the number of males, with the situation being reversed in Grades 10, 11 and 12, where the ratio of males to females increased steadily. A possible explanation of this feature is that, with the exception of the schools that appear in the top 10, the learners essentially volunteer to take part in either the "individual" or "pairs" competition. It has been noted in an earlier chapter that females, on the whole, may tend not to enjoy a competitive environment and that females may tend to prefer working co-operatively as opposed to individually. This tendency could explain why the proportion of females entering the competition on an individual basis declines in the senior grades.

Table 2 Difference in the mean number of correct responses, incorrect responses and omitted questions [mean (males) - mean (females)]

Grade	Correct	Incorrect	Omitted
8	1.3	0.1	-1.4
9	3.4	-2.5	-0.9
10	2.5	0.2	-2.7
11	2.1	-1.1	-1.0
12	1.4	-0.4	-1.0

Table 2 exhibits the following patterns: the males consistently answer more questions correctly than do the females; females consistently omit more questions than do the males, indicating that females are less likely to take risks than are the males (in this competition, an omitted question is awarded one mark, which should discourage guessing as no marks are awarded for an incorrect answer). These results reflect those of Marshall (1983), who found that females consistently omitted more questions in a multiple-choice question paper than did the males.

Categories

Broad categories

Each competition question was placed into one of the categories: Arithmetic, Algebra, Geometry or Problem Solving. These categories were essentially mutually exclusive as will be explained in the next section, where the broad categories were subdivided into more specialised categories.

Mutually exclusive categories

Using the categories defined by Taylor, et al. (1996), the four broad categories were then subdivided into eight sub-categories, termed "mutually exclusive" categories, since all the questions could be placed into only one of the defined categories.

Table 3 Categories

Basic Arithmetic	Routine Arithmetic
Basic Algebra	Routine Algebra
Basic Geometry	Routine Geometry
Problem Solving	Nonroutine Problem Solving

The categories were chosen with the following in mind:

Questions that were included in the "basic" categories were those that are based on the school syllabus, do not have a language component, and where skills were tested in a direct manner. In the categories defined as "routine", problems which are harder than those in the "basic" categories are included. These problems also contained some language component or may require a modelling aspect. Generally these problems tested only one area of mathematics, either arithmetic, algebra or geometry. It is important to note that those problems involving simple counting techniques that would not normally have been included in the Problem Solving category, were included in the category of Arithmetic. The Problem Solving category generally includes problems that required the application of skills from more than one of the other categories (arithmetic, algebra and geometry). Such problems are often similar to those encountered in the classroom situation and thus could be solved using familiar techniques and methods. On the other hand, the category "Nonroutine problem solving " was the section in which the learners were faced with unfamiliar situations. Such questions were generally the most difficult on the question papers. As a result of being situated close to the end of the paper, the abstention rates on such problems were generally quite high. Thus the statistics should be interpreted with a certain measure of caution.

Special categories

Of further interest were the categories:

- 2 dimensional Geometry (diagram provided)
- 2 dimensional Geometry (no diagram provided)
- 3 dimensional Geometry (diagram provided)
- 3 dimensional Geometry (no diagram provided)
- Enumeration
- Mechanics
- Ratio

A question classified as a mechanics problem would be one involving speed or velocity. There was only one question (repeated in Grades 10, 11 and 12) that was classified in this category. The Enumeration category included all questions involving counting techniques and probability. As with the Mechanics category, Ratio also involved only one question (repeated in Grades 8, 10 and 12) with a further question asked only in Grade 12. These Special Categories were not mutually exclusive. A question could be classified in more than one category and not all questions could be put into one of the special categories.

CATEGORIES OF QUESTIONS

Key:
Mutually Exclusive Categories (ME):
Basic Algebra (BA), Routine Algebra (RA), Basic Arithmetic (BAR), Routine Arithmetic (RAR), Basic Geometry (BG), Routine Geometry (RG), Problem Solving (PS), Nonroutine Problem Solving (NPS).
Special Categories (SC):
Geometry, 2D, Diagram Provided (2D); Geometry, 2D, no diagram provided (2DN); Geometry, 3D, diagram provided (3D); Geometry, 3D, no diagram provided (3DN); Mechanics (M); Enumeration (E); Ratio (R)

Table 4

Ques	Grade 8		Grade 9		Grade 10		Grade 11		Grade 12	
No.	ME	SC	ME	SC	ME	SC	ME	SC	ME	SC
1	BAR		BAR		BAR		BA		BA	
2	BAR		BAR		BAR		BG	E	BAR	
3	BAR		BA		BG	2D	BG	2D	BG	
4	BAR		BAR		RAR		RAR		BG	2D
5	BG	2D	BG	2D	BG	2D	BG	2D	BA	
6	BAR		BAR		BG	2D	BG	2DN	BAR	
7	RAR	E	RAR	E	RAR		BA		BAR	
8	RAR		RAR		BG	2D	RG	2DN	RAR	R
9	RAR	E,2D	BG	2D	BA		RAR		RAR	
10	BG	2D	BG	2D	BG	2DN	RG	2DN	RG	2D
11	RAR		RAR		BAR		RAR		RA	
12	RG	2D	RG	2D	BAR		BG	2DN	RG	3D
13	RAR		RAR		RAR	R	PS		PS	
14	PS	E	RA		RAR		RG	2D	RG	2D
15	RAR		RG	2DN	RAR		BG	2D	RA	
16	RA		RAR	E	BG	2D	RG	2DN	RA	

Ques No.	Grade 8 ME	Grade 8 SC	Grade 9 ME	Grade 9 SC	Grade 10 ME	Grade 10 SC	Grade 11 ME	Grade 11 SC	Grade 12 ME	Grade 12 SC
17	PS		RAR		RG	3D	RA		RG	2D
18	PS	E	PS		RG	2D	RA		RA	
19	RG	2DN	RAR		RG	2D	RA		RAR	R,3DN
20	RAR	R	RG	2D	RG	2D	PS	M	NPS	
21	RAR		PS		RG	3D	NPS	E	RA	
22	RG	3D	RG	2DN	RA		NPS	E	RAR	
23	RG	2DN	RA		RA		NPS		RG	2DN
24	PS		PS		PS	M	RG	2D	RG	2D
25	NPS		RG	2D	NPS	E	NPS		NPS	M
26	NPS		RG	2D	NPS		NPS		NPS	
27	NPS	E	NPS	E	NPS	E	NPS	2DN	NPS	2DN
28	NPS	E	NPS	E	NPS		NPS		NPS	3D
29	NPS	E	NPS		NPS	3D	NPS	3D	NPS	
30	NPS		NPS		NPS		NPS		NPS	

Analysis

For each of the above categories, total scores were calculated and *t-tests* were performed on the totals obtained for each category within each grade, using the STATISTICA programme, to determine whether any statistically significant differences existed between genders. For those questions that were repeated in more than one grade, the scoring was standardised in that if a candidate's answer was correct four marks were awarded, a wrong answer received no marks, and an omitted question received one mark. This was done owing to the fact that a question's value was originally determined by its positioning in the relevant question paper and for the repeated questions it was only of interest whether the answer was correct or not. A two-way analysis of variance (ANOVA) was performed on each of the repeated questions in order to determine whether any observed differences were due to gender only, to maturity in mathematics only or to a combination of these factors.

In the research conducted by Taylor, et al. (1996), the following conclusions were cited from a previous study:

> males obtained generally higher scores in each of the mutually exclusive and special categories. ... They found that the highest such differences were on items in mechanics while items in geometry, 3-dimensions with no diagram (requiring spatial perception) recorded a remarkably small difference between females and males. Further, they reported increasingly higher differences at the higher year levels.
>
> (Annice, Atkins, Pollard and Taylor, cited in Taylor, et al. 1996, p. 7)

Broad categories

Table 5 is a summary of the results obtained from performing a *t-test* on each of the categories as well as the final result of each paper

Table 5 Results of *t-tests* in each of the broad categories

	t-values				
Year	Arithmetic	Algebra	Geometry	Problems	Total
Grade 8	1.048	2.385*	2.474*	1.777	1.967
Grade 9	4.621**	4.053**	5.248**	4.508**	6.034**
Grade 10	4.320**	2.865**	4.634**	0.577	4.705**
Grade 11	0.512	3.017**	4.286**	4.350**	4.853**
Grade 12	1.587	1.562	3.317**	2.317*	3.010**

* $p < 0.05$

** $p < 0.01$

Table 6 **Number of questions in each broad category**

Year	Arithmetic	Algebra	Geometry	Problems
Grade 8	13	1	6	10
Grade 9	11	3	9	7
Grade 10	9	3	11	7
Grade 11	3	5	11	11
Grade 12	7	7	8	8

From table 5, it can be seen that where differences were detected, these differences were in favour of the males. The following patterns in differences in performance can be observed:

It is only in Grades 9 and 10 that any statistically significant differences in Arithmetic have been observed. At the Grade 8 level, there was only one question in Algebra, and on that question a statistically significant difference was found in favour of males. From Grades 9 to 11, there are also statistically significant differences in favour of males although it appears that these differences are becoming smaller in the higher grades, until in Grade 12 these differences are no longer statistically significant. Statistically significant differences in favour of males have been observed at all levels in the category of Geometry (involving spatial skills). Once again it appears that these differences in Grade 8 are small, increasing substantially in Grade 9 and then becoming smaller in subsequent years. A similar pattern is observed in the category of Problem Solving, although the differences observed at the Grade 8 and 10 levels are not statistically significant. The pattern in the differences detected in the overall total/score seem to follow a similar pattern of no statistically significant differences observed at the Grade 8 level, the observed differences increasing markedly and becoming statistically significant in favour of males at the Grade 9 level and then the statistically significant differences seeming to decrease with time in the subsequent years.

Mutually exclusive categories

Table 7 Results of *t-tests* in each of the mutually exclusive categories

Category	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
Basic Arithmetic	1.251	3.698**	3.277**		-0.382
Routine Arithmetic	0.649	4.668**	3.733**	0.512	2.711**
Basic Algebra		0.894	1.711	2.799**	-0.347
Routine Algebra	2.385*	4.639**	2.801**	2.283*	1.744
Basic Geometry	-0.612	3.143**	5.249**	4.410**	3.156**
Routine Geometry	3.370**	5.050**	1.138	2.636**	2.605**
Problem Solving	1.635	5.548**	0.299	4.223**	1.864
Nonroutine Problem Solving	1.182	1.078	0.550	3.324**	2.013*

* $p < 0.05$

** $p < 0.01$

Table 8 Numbers of questions in each mutually exclusive category

Category	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
Basic Arithmetic	5	4	4		3
Routine Arithmetic	8	7	5	3	4
Basic Algebra		1	1	2	2
Routine Algebra	1	2	2	3	5
Basic Geometry	2	3	6	7	2
Routine Geometry	4	6	5	5	6
Problem Solving	4	3	1	1	1
Nonroutine Problem Solving	6	4	6	9	7

It should be stressed that caution needs to be exercised when interpreting the results in this section which deal with categories containing relatively few questions. Bearing this in mind, the following observations can be made: In the Arithmetic category, no differences were detected in the "basic" subcategory in Grade 12 while statistically significant differences in favour of the males were found in the routine category. A similar pattern is observed in the Problem Solving category where statistically significant differences are apparent in the nonroutine section whereas no differences are detected in the ordinary problem solving (although this is based on only one question).

In Grade 8, it is noticed that there are no statistically significant differences in all the mutually exclusive categories, with the exception of the routine algebra and the routine geometry categories. This could be explained by the fact that it is only at the beginning of grade 8 that the learners are introduced to the concept of algebra (in a formal way) and this category is only based on one question. From the results of the broad categories and the total score, the observed patterns in performance in Grade 8 are not surprising.

The largest statistically significant differences in the broad categories, as well as the mutually exclusive categories are observed in Grade 9. It is at about this stage in the learner's development that, according to the literature, statistically significant differences appear. The only two categories not exhibiting statistically significant differences are the basic algebra (only one question) and the nonroutine problem solving (comprising four questions). Since the nonroutine problem solving questions are generally placed towards the end of the question paper and the abstention rates are particularly high (because of time constraints and the questions being very difficult), it is unsurprising that no statistically significant differences are reflected, even though it is apparent that (in Grade 9) significant differences are reflected in all other categories.

Special categories

Table 9 Results of *t-tests* in each of the special categories

Category	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
2D Geometry (with diagram)	1.906	5.171**	4.860**	3.605**	1.489
2D Geometry (no diagram)	0.786	3.297**	0.299	3.545**	4.417**
3D Geometry (with diagram)	0.730		1.158	-1.189	0.642
3D Geometry (no diagram)					2.840**
Mechanics			0.299	2.178*	1.944
Enumeration	1.009	3.293**	1.569	3.831**	
Ratio	-0.159		1.580		3.117**

* $p < 0.05$

** $p < 0.01$

Table 10 Number of questions in each of the special categories

Category	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
2D Geometry (with diagram)	4	7	8	4	4
2D Geometry (no diagram)	2	2	1	6	2
3D Geometry (with diagram)	1		3	1	2
3D Geometry (no diagram)					1
Mechanics			1	1	1
Enumeration	7	4	2	3	
Ratio	1		1		2

The 2D Geometry (diagram provided) involved a large number of questions and the pattern of statistically significant differences appearing in the Grade 9 level, continued in the Grades 10 and 11, but the differences became insignificant at the Grade 12 level. The differences in the 2D Geometry (without a diagram) demonstrate that where there have been no differences at the grade 12 level when a diagram is provided, differences are now statistically significant when no diagram is provided. This observation would seem to support of the other studies undertaken which found that in questions requiring a greater spatial ability, males tended to perform better than their female counterparts. Even though at the Grade 10 level the differences appear to be insignificant, the results are only based on one question. A similar pattern is observed in the case of the 3D Geometry questions in that when a diagram is provided the females tend to do better than when no diagram is provided, supporting the literature that states that boys perform better on questions requiring more highly developed spatial skills.

Since there were very few questions on Mechanics and Ratio, these results should be interpreted with care and are clearly not generalisable. In the Ratio section, statistically significant differences in favour of males appeared at the Grade 12 level and on looking at the individual question analysis, the results of the *t-tests* point towards significant differences in performance in both of the these questions.

Repeated questions

As stated before (p. 33-34), a series of one and two-way ANOVA's were performed on the data. Two one-way ANOVA's were performed using gender as the variable in the first case and the year (grade) as the variable in the second case. A two-way ANOVA was performed using the gender and year as the variables. The results of these tests, as well as the individual gender within grades *t-test* results (which detect any statistically significant differences within a Grade) for the relevant question in each grade that it appeared are given in Table 11.

Table 11 Repeated question data

(Question number refers to the first grade in which that particular question appeared; with 6=Grade 8, 7=Grade 9, 8=Grade 10, 9=Grade 11 and 10=Grade 12)

Quest. No.	ANOVA (F-values)			*t - test* (t-values)				
	YRxG	Gender	Year	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
6.1	4.631**	6.581*	0.300	-0.041	3.535**			
6.4	2.868*	0.136	5.168**	0.934		-0.130		-1.770
6.6	1.540	4.487*	0.085	1.555	1.290			
6.7	4.641**	1.189	6.113*	-0.884	2.676**			
6.8	2.210	0.387	5.734*	-0.927	0.074			
6.9	5.191**	9.719**	5.938*	1.587			2.688**	
6.10	4.045**	9.466**	0.527	1.129	3.272**			
6.11	8.274**	5.917*	16.855**	0.435		2.821**		
6.12	9.969**	31.161**	6.908**	3.044**	4.877**		2.019**	
6.15	7.200**	4.054*	15.156**	0.687	2.028*		0.529	
6.16	19.045**	33.448**	32.667**	2.385*	4.233**	1.711	3.176**	0.621
6.19	2.304*	5.228*	3.047*	0.786	2.197*	0.299	1.145	
6.20	2.796*	4.611*	3.777*	-0.159		1.580		1.989*
6.22	2.265*	1.616	3.773*	0.730		1.885		-0.347
6.23	7.107**	10.197**	9.730**	2.096*	2.481*			
6.26	5.725**	24.261**	5.033**	1.687	2.279*		3.590**	1.864
6.28	2.803**	11.436**	1.563	0.519	1.496	1.451	3.085**	
6.29	0.879	3.373	0.235	0.861	0.442		1.580	
6.30	0.734	0.153	1.210	0.024	0.283	-0.483	1.229	0.078
7.3	15.971**	4.039*	38.325**		0.709		1.463	-0.153

Quest. No.	ANOVA (F-values)			*t - test* (t-values)				
	YRxG	Gender	Year	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
7.5	1.365	2.521	0.375		0.095	1.970*		
7.10	5.893**	10.609**	5.651*		2.460*	2.406*		
7.11	14.188**	42.343**	0.999		4.476**	4.450**		
7.16	3.286*	9.127**	0.188		2.609**	1.600		
7.19	6.24	15.736**	0.040		3.970**	1.662		
7.20	11.789**	34.393**	0.104		3.550**	4.744**		
7.26	0.362	0.468	0.395		0.876	0.258		
7.29	0.396	1.166	0.294		0.451	0.757	0.955	
8.6	11.144**	26.731**	7.076**			3.592**		3.637**
8.8	7.760**	18.497**	8.599**			3.600**	2.740**	1.105
8.11	2.222	4.973*	0.603			3.059**	0.952	-0.088
8.12	27.111**	3.239	78.021**			1.841		0.614
8.18	1.957	0.698	5.154*			0.814		0.293
8.20	2.572*	1.887	2.397			-0.370	2.124*	
8.22	1.231	0.010	2.000			1.378	-0.259	-0.774
8.23	12.202**	14.579**	21.369**			2.843**	2.679**	
8.24	2.092	2.889	1.168			0.300	2.178*	
8.26	1.382	0.913	0.382			-0.272	1.835	
8.29	0.976	0.003	0.669			-0.005	-1.189	1.375
9.14	3.834**	4.540*	5.594*				0.580	2.302*
9.30	0.943	0.003	1.431				-0.774	0.886

* $p < 0.05$

** $p < 0.01$

Using the data in table 11, the questions were split into four categories: difference detected due to gender only; difference detected due to grade/maturity in mathematics only; difference detected due to a combination of gender and maturity; and very small or no statistically significant difference detected.

Table 12 Division of questions into categories of factor for difference

Gender only	Year only	Gender and Year	No effect
6.1	6.19	6.20	7.26
7.16	6.22	9.14	7.29
6.10	6.4/10.2	6.26	6.30
6.9	6.7	6.23	6.29
7.10	6.15	8.8	9.30
6.28	6.11	6.12	8.29
7.19	7.3	8.6	8.22
7.20	8.12	8.23	7.5
7.11		6.16	8.26
			6.6
			8.18
			8.24
			6.8
			8.11
			8.20

In the above table, the questions are "ranked" in that the effect increases in size as one moves down the columns. With regard to the effect of maturity in mathematics, it is expected that students in a higher year should demonstrate improved performance in all questions. However, from the data reported in tables 11 and 12, it is clear that this does not happen in all cases.

One question which is of particular interest in the category in which maturity in mathematics does affect the result, is question 6.4, which was set as question 2 in Grade 10 and a variation of the question was set as question 2 in Grade 12.

6.4 What is 75% of 72?

10.2 What is 72% of 75?

The variation involved the concept of commutativity of multiplication. Since the F-value is small, it is possible to assume that the commutative property was not obvious in Grade 12, since the improvement in performance is not substantial.

Of the questions in which the difference detected was due only to gender, six of the nine questions required the use of some spatial skill (6.9, 6.10, 7.10, 7.20, 6.28, and 7.19), two of the questions were classified as arithmetic (6.1 and 7.11) and one question involved probability (7.16). Two of the questions involving spatial skill required the use of some sort of transformation of an object (6.10 and 7.10). 6.10 required the candidates to rotate a number of puzzle pieces in order to find the correct "fit". The fact that there was no improvement in performance relative to maturity in mathematics may indicate that a candidate's ability to perform routine transformations has not improved with time. The statistically significant gender difference in performance, however, remains. Upon first looking at question 7.10, it would not be unreasonable to expect that the females should outperform the males, since it is a question that is set almost entirely within the female domain (from a traditional viewpoint). The results, however, indicate that the males possess superior visualisation skills regardless of the subject matter and the setting of this particular question.

Of particular interest are the questions in which no improvement was apparent over a number of years. Nine of the fourteen questions appeared in the "difficult" section of the papers, with high abstention rates, so that any possible differences were not perhaps detected owing to the small sample size. It is often in these difficult questions that the brighter students attempt the questions, with the weaker students abstaining. Thus it could be concluded that maturity in mathematics is less of a factor in performance among the brighter students on these questions.

One question, namely 6.30 or "Bud the Spud" produced a very interesting set of results. Even though the question appeared in the difficult section of each paper (as question 30 in Grade 9, 28 in Grade 10, 26 in Grade 11 and 20 in Grade 12), the response to the question was remarkably good. This question was also run in the Australian Mathematics Competition in 1985, and similar results were reported in their competition. In Table 13 a comparison of the two competitions is made with regard to "Bud the Spud":

Table 13 Comparison of the results of the University of Cape Town Mathematics Competition and Australian Mathematics Competition for the question "Bud the Spud" (percentage correct is given)

Grade	UCT Mathematics Competition		Australian Mathematics Competition	
	Males	Females	Males	Females
8	28.1	27.4		
9	34.8	32.6	32.1	32.1
10	30.2	31.7	29.8	29.4
11	30.4	24.1	30.2	28.6
12	29.2	29.1	33.2	28.0

(Australian Mathematics Competition results obtained from correspondence with Prof. Peter Taylor, Faculty of Information Sciences and Engineering, University of Canberra)

It is clear from the above table that maturity in mathematics has not influenced the performance on this particular question in either the University of Cape Town Mathematics Competition or the Australian Mathematics Competition. A closer analysis of the responses in the University of Cape Town Mathematics Competition reveals that the above results were not due to random answering: the abstention rates were approximately the same as the percentages getting the correct solution. Of the remaining candidates who answered the question incorrectly, the answers were equally distributed among the remaining options. The percentage responses to this question could indicate that the learners in the junior grades may have been getting the question correct for the wrong reasons, resulting in similar statistics being reported in each grade. An interesting activity, which is beyond the scope of this study, would be to interview a number of the candidates on their approach to this particular question as this would go a long way to explaining these anomalous results.

One other question of interest is question 5 (grade 9), also set as question 3 in grade 10. This question was a geometry question and should have theoretically also shown improved performance with maturity in mathematics. A possible explanation for this apparent anomaly is that the question was possibly "too easy", with 90.5% and 92.2% getting the question correct in Grades 9 and 10 respectively.

Distribution of candidates by quintile

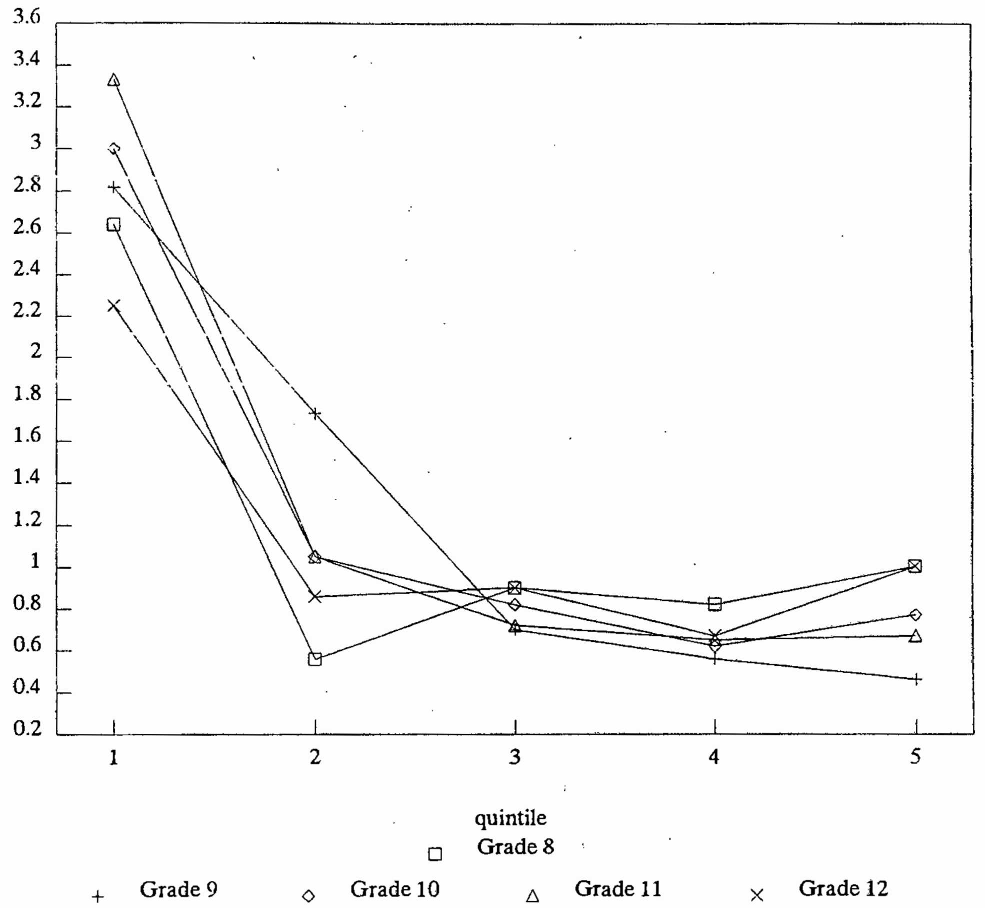
In the analysis of the University of Cape Town Mathematics Competition, the candidates are divided into quintiles on the basis of their total scores. Since this is done before a gender analysis is done, the quintile split is based on the results of the whole group. Table 14 below gives the ratio of each gender in each quintile, within each grade.

Table 14 Distribution of each gender into quintiles (values given are the ratio of each gender in the quintile to the total of each gender participating in that grade)

Grade	Gender	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
8	Male	0.29	0.14	0.19	0.18	0.20
	Female	0.11	0.25	0.21	0.22	0.20
9	Male	0.31	0.26	0.16	0.14	0.12
	Female	0.11	0.15	0.23	0.25	0.26
10	Male	0.30	0.20	0.18	0.16	0.17
	Female	0.10	0.19	0.22	0.26	0.22
11	Male	0.30	0.20	0.18	0.15	0.16
	Female	0.09	0.19	0.25	0.23	0.24
12	Male	0.27	0.19	0.19	0.16	0.20
	Female	0.12	0.22	0.21	0.24	0.20

Table 14 clearly illustrates that within the top quintile (quintile 1), the males far outnumber the females. This dominance is in keeping with what has been reported in the literature in that at the top end of achievement, there seem to be relatively few females.

Graph 1 Ratio of males to females versus quintile



Graph 1 shows the relationship of the ratio of males to females within each quintile very clearly. The ratio of males to females decreases from being almost 3:1 in each grade (with the exception of Grade 12, where it is 2.2:1) to being below 1:1 in almost all the other quintiles. What this means is that, although in the top quintile there is a relatively large number of males, the females tend to be concentrated in the second quintile and below. The Grade 9 results show a slightly different pattern in that the males outnumber the females in the ratio of approximately 1,7:1 in the second quintile. This could help explain the earlier result indicating that the highest statistically significant difference found on the total score was in Grade 9.

RESULTS AND DISCUSSION: ATTITUDE

As with the results and discussion of the gender-related performance, the analysis and discussion of the attitudes questionnaire will adopt a two step approach in an attempt to find different patterns and links between the various questionnaire items and the total score on the performance section of the University of Cape Town Mathematics Competition.

In the first part of the analysis, gender related differences, as well as similarities, in attitudes will be explored using the attitudes questionnaire. The attitudes questionnaire was designed with the help of an instrument used by Dr. L.S. Cronjé of the University of the Witwatersrand. This instrument had been adapted from the original Fennema-Sherman Attitude Scales (Visser, 1985). Owing to the limited time available during the writing of the University of Cape Town Mathematics Competition, the number of items included in the attitudes questionnaire had to be limited. The result was the sixteen item questionnaire, presented in its original form, in Addendum B. The responses to the items were based on a Likert-type scale where the scale ranged from (1) "strongly agree" to (5) "strongly disagree", with an option of "no opinion" (3). The items were originally allocated to the following categories:

Confidence

1 I don't usually feel nervous during a maths class.
5 I have always enjoyed studying mathematics at school.
6 I get a sinking feeling when I have to think about a hard maths problem.
8 Mathematics doesn't scare me at all.

Motivation

2 Mathematics is very interesting
7 Mathematics is boring, because it leaves no room for personal

achievement.

11 Once I start working on a mathematics puzzle, I find it difficult to stop.

13 I like mathematics problems that contain some challenge.

15 I don't understand how some people can spend so much time on mathematics and seem to enjoy it.

Male/Female Domain

3 Women are certainly logical enough to do well in mathematics.

9 I would trust a women just as much as a man to figure out important calculations.

12 Men are naturally more interested in the sciences and women in the arts and social sciences.

Usefulness

4 Mathematics helps to develop your mind and teaches you to think.

10 I am willing to use mathematics in a future job.

14 Too much emphasis is currently being placed on the importance of mathematics.

16 Mathematics is less important than art or literature.

The second part of the analysis will be an attempt to draw conclusions from the correlation coefficients relating each item to the total score. In this way, a possible relationship of specific types of attitudes and performance in mathematics, or ability in mathematics could be explored.

Unfortunately, not all the candidates responded to the attitudes questionnaire. In Grade 12, it can be seen that the numbers responding to the attitudes questionnaire dropped significantly. The reason is that the invigilators had not given clear instructions to the candidates to complete the attitudes questionnaire.

Table 1 **Number of each gender completing the attitudes questionnaire**

Grade	Males	Females
8	144	156
9	135	162
10	179	164
11	172	163
12	118	114

Gender related differences in attitudes towards mathematics

In order to determine whether there was evidence of any gender related differences in attitudes, *t-tests* were performed on each item, within each grade. The data of all the grades were combined and a *t-test* was performed on the data in order to detect differences on the much larger sample size. In the table below, the results of this analysis are shown.

Table 2 **Results of *t-tests* performed on each item in the attitudes questionnaire**

Item number	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12	Combined
1	0.776	-0.700	-1.043	-1.274	0.040	-0.918
2	-1.197	-0.585	0.340	0.254	0.046	-0.258
3	7.295**	6.725**	7.904**	8.662**	10.428**	18.109**
4	0.512	-0.918	0.976	0.753	0.304	0.823
5	-1.387	-0.242	0.975	-0.154	-0.558	-0.417
6	0.994	1.530	3.517**	2.316*	1.659	4.347**
7	-0.089	-0.388	-0.913	-0.037	0.788	-0.469
8	-2.787**	-4.932**	-4.925**	-2.892**	-3.940**	-8.124**
9	3.733**	4.700**	6.367**	5.878**	6.950**	12.360**
10	-1.498	-1.314	0.698	-1.325	-1.577	-2.145*
11	0.048	-0.858	-1.186	-0.335	-0.365	-1.139
12	-4.891**	-5.599**	-6.899**	-5.403**	-5.680**	-12.673**
13	-0.870	-2.194*	-2.452*	-2.402*	-0.976	-3.880**

Item number	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12	Combined
14	-1.182	0.962	0.309	2.879**	0.368	1.442
15	-0.550	0.707	-0.144	0.102	0.233	0.173
16	0.480	-0.021	-0.567	0.730	0.320	0.333

* $p < 0.05$

** $p < 0.01$

From the above table, it can be seen that the males and females who responded to the attitudes questionnaire exhibited very similar attitudes to mathematics. In Grades 8 and 12, there were only four items in which statistically significant differences were found. In Grade 9, there were five items in which statistically significant differences were detected. It is in Grades 10 and 11 that the largest number of statistically significant differences were found.

Mathematics as a male domain

From table 2, it is clear that the largest statistically significant differences (based on the results of the *t-tests* on each grade as well as the combined group) can be found on items 3, 9 and 12. These items all refer to a situation in which some case of gender bias is depicted. It is found that, across all grades, the males display more "sexist" views than do females, consistently stereotyping mathematics as a male domain. The item in which the opinions expressed by the two gender groups seem to be divided the most is item 3. Upon closer examination of the statistics, it is apparent that the females tend to agree strongly with the statement. The males on the other hand do not seem to be, on average, as firm in their agreement of the statement, with the majority of the males tending to be neutral in their approach to this statement.

The results of the *t-tests* performed on the combined sample indicates that these differences are the largest and also indicate that a more stereotyped view of mathematics as being a male domain is held by the males who have taken part in the University of Cape Town Mathematics Competition. This is not to say that the males are totally sexist, believing that females have no part in mathematics. On the contrary, the males in the sample do not seem to have very strong opinions either way! On average, the responses of the males tended to be between the "no opinion" (option 3) and either the "agree" (option 2) or the "disagree" (option 4) options, depending on the statement. In other words, the males do not seem to mind the involvement of females in mathematics - they are fairly non-committal about their views on females and mathematics.

Confidence

The results of the *t-test* performed on the combined sample indicate that items 6 and 8 exhibit statistically significant differences. From the results of the *t-tests*, statistically significant differences appear in all five grades for item 8. At the junior level, in Grades 8 and 9, the males tend to agree strongly with the statement, while the strength of the females agreement with the statement is not as strong. In the senior levels, in Grades 10, 11 and 12, both the males and the females seem to change their views, with both sets of statistics revealing that the strength of their opinions drops. Although the average levels have not dropped sufficiently so that the opinions expressed appear to agree with item number 8, the change does seem to indicate that the confidence levels of both the males and the females have dropped markedly.

Item number 6 is also identified by the *t-test* performed on the combined sample as having large statistically significant differences. From the *t-tests* performed on the individual grades the differences do not seem to be particularly significant, indicating that the gender effect of this item is much smaller than for item 8. The data reveals that both the genders tend to disagree with the statement (item 6) which indicates that both genders feel reasonably confident about tackling difficult mathematics problems. This, however, is expected since the sample that has been tested (the candidates who have been entered in a mathematics competition) should be reasonably competent in tackling difficult mathematics problems, and thus should have a certain measure of confidence in their own ability.

Motivation

There were only two other items that were identified as having statistically significant differences. These are item numbers 10 and 13. The differences that appear are not as large as those in the previous two categories. These differences in fact only appear in the combined sample and thus could be the result of a much increased sample size and increased sensitivity of the *t-test.* For item number 13, the *t-tests* on the individual grades indicate that statistically significant differences are evident only in grades 9, 10 and 11, with the males seeming more likely to enjoy doing challenging mathematics problems.

The overall indication is that females and males tend to exhibit very similar attitudes towards motivation in mathematics. As has been mentioned before, such results are to be expected since these candidates are motivated about using mathematics in a future career as well as being motivated to achieve in the more challenging areas of mathematics.

Overall attitude

On the remaining nine items, there were no statistically significant differences in opinion between the males and the females. These remaining nine items do not seem to express particularly extreme views/attitudes towards mathematics. The candidates are generally keen participants in activities of a mathematical nature and are doing mathematics because they enjoy the subject and not because they have been forced to do it due to parental pressure or otherwise. Possibly as a result of this, there were no statistically significant differences on those items pertaining to the usefulness of mathematics.

Correlation of attitudes and total score

In this section, any relationship between individual items and the total score on the Competition will be investigated. The results have been tabulated according to gender in order to make any patterns clearer, since it is patterns within each gender that are being investigated.

It should be noted that in this section, a negative correlation coefficient will not be interpreted in the usual sense, in that such a correlation coefficient indicates no correlation between the two sets of data. A negative correlation coefficient indicates that the candidates with the higher scores tended to "agree" with the given statement, thus choosing a lower option. If the statement had been phrased differently, the correlation coefficients would have been positive.

Males

Table 3 Correlation coefficients of item and total score for the males

Item number	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
1	-0.157	-0.324*	-0.242*	-0.129	-0.277*
2	0.086	0.013	0.137	-0.014	0.068
3	-0.229*	-0.182*	-0.200*	0.004	-0.010
4	0.034	-0.120	0.109	-0.034	0.091
5	0.068	-0.005	0.057	-0.060	-0.103
6	0.234*	0.508*	0.249*	0.264*	0.310*
7	0.074	0.024	-0.089	0.092	0.174
8	-0.355*	-0.228*	-0.187*	-0.172*	-0.144
9	-0.116	-0.143	-0.072	0.013	-0.035
10	-0.174*	-0.122	0.010	-0.098	-0.046
11	-0.248*	-0.203*	-0.026	0.020	-0.094
12	0.152	0.067	-0.055	0.027	0.170
13	-0.253*	-0.450*	-0.099	-0.040	-0.166
14	0.268*	0.197*	0.288*	0.306*	0.163
15	0.235*	0.278*	0.123	0.182*	0.107
16	0.114	0.225*	0.056	0.020	-0.103

* $p < 0.05$

The following patterns have been identified in table 3:

A number of items showed no significant correlation with total score. These items include 2, 4, 5, 7, 9, 10, 12 and 16. Upon inspection of the statements contained within these items (see Addendum B), the results obtained are possibly the expected results when the nature of the sample and the conditions under which the attitudes questionnaire was completed are taken into account. In the previous analysis, it was mentioned that the sample generally consisted of those learners who are interested in mathematics and enjoy doing the subject, view mathematics as being important and are willing to use it in their future careers.

The eight remaining items exhibited statistically significant correlation coefficients in two or more of the grades. Six of these items can be grouped together into two main categories. The other two items cannot be grouped together or placed in either of these two categories. The results of item 3 ("Women are certainly logical enough to do mathematics") shows that the younger, more able male students, tend to agree with the statement, whereas in the senior grades (11 and 12), the more able males become rather non-committal. The correlation coefficients for item 14 ("Too much emphasis is currently being placed on the importance of mathematics") indicate that the more able male students tend to disagree with the statement.

Confidence

Items 1, 6 and 8 essentially deal with students' confidence in their ability in mathematics. The results obtained on each of these items are to be expected. The more able male students tend to display more confidence in their own ability. Since the correlation coefficients are not particularly high, although they are statistically significant, the implication is that the male students are generally similarly confident in their ability in mathematics, regardless of their result in the University of Cape Town Mathematics Competition.

Motivation

The correlation coefficients of the remaining items (11, 13 and 15) with total score were not statistically significant in all five grades. It is only in the junior grades (Grades 8 and 9) that the more able male students tend to display greater motivation in mathematics. The implication could be that, since the learners in the senior grades (Grades 10, 11 and 12) have made the commitment to study mathematics as one of their choice subjects, they should all enjoy mathematics and be sufficiently motivated to achieve in the subject.

Females

Table 4 Correlation coefficients of item and total score for the females

Item number	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
1	-0.278*	-0.269*	-0.187*	-0.179*	-0.050
2	0.086	0.121	0.244*	0.018	0.139
3	-0.187*	-0.223*	-0.126	-0.240*	-0.180
4	-0.059	-0.107	0.095	0.058	-0.011
5	-0.077	-0.018	0.078	-0.145	0.023
6	0.315*	0.275*	0.267*	0.230*	0.011
7	-0.054	0.022	-0.083	0.149	0.068
8	-0.173*	-0.225*	-0.165*	-0.193*	-0.078
9	-0.321*	-0.301*	-0.094	-0.255*	-0.161
10	-0.168*	0.043	0.145	0.053	-0.155
11	-0.084	0.023	0.042	-0.069	0.037
12	0.202*	0.133	0.085	0.055	0.290*
13	-0.278*	-0.121	0.001	-0.208*	-0.164
14	0.259*	0.149	0.167*	0.265*	0.333*
15	0.183*	0.122	0.006	0.205*	0.204*
16	0.081	-0.206*	-0.127	0.088	0.148

* $p < 0.05$

The results of the correlation of the items with the females' score on the University of Cape Town Mathematics Competition are very similar to those of the males, with a few exceptions. Of the items on which no significant correlation coefficient was found item 13 is included with those of the males, while items number 9 and 12 are excluded. It is interesting to note that the females and males follow a similar pattern when it comes to items found on the confidence and motivation scales. The more able female students appear to be more confident in their own ability and tend to be more motivated to achieve. As with the male sample, the correlation coefficients do not imply that the less able students (within the context of the University of Cape Town Mathematics

Competition) are not motivated or confident in their ability.

Gender

Items 3, 9 and 12 do not show particularly strong correlations with the total score. These items are however included since there were two or more grades in which the correlation coefficients were statistically significant. These relatively weak correlations indicate that the female students of differing abilities generally have similar attitudes towards the part that women should play in mathematics.

CONCLUSION

In an attempt to draw conclusions, it is important to bear in mind that these results can not be generalised, without reservation, to the wider population. The data has been collected from a relatively select group of candidates, although still representative of a wide range of ability.

The research question that was proposed at the beginning of this study asked the following:

- Are there any gender related differences in performance in mathematics? If so, are these differences statistically significant?
- In terms of the learners' attitudes to mathematics, are there any gender related differences (or similarities) in attitudes? To what extent do these attitudes contribute towards a learners' performance in mathematics?

In this conclusion, an attempt will be made to draw together the results obtained in the previous chapters and to make the connection with the results reported in the literature survey.

Summary of results

Performance

The results obtained in this study tend to mirror those reported in the literature. Gender related differences in performance in mathematics were found to emerge at the Grade 9 level, which is roughly at the same stage that such differences were found to emerge as reported in the literature (in the early high school years). Visser (1987) reported that even though she had found no overall mean differences at the Grade 12 level, there were substantial differences in the number of males and females at the upper end of the ability scale. A similar result was found in this study in that in the top twenty percent of candidates in each grade, the males outnumbered the females in the approximate ratio of 3:1. The ratio of males to females then decreases markedly in the lower ability scales.

With regard to the distinct areas of mathematics being tested for statistically significant differences, the following results have been found:

- In the broad categories and the overall score, the general pattern has been observed that the statistically significant differences emerge in all categories only at the Grade 9 level and then decrease in size (and yet still often remain statistically significant) in the subsequent grades. In these categories, the results reported in the literature seem to be confirmed in this sample in that it has been found that males outperform females in the areas of Geometry and Problem Solving. The smallest differences found in this study have been in Arithmetic and Algebra, which are two categories which the literature reports to have no statistically significant differences.
- In the mutually exclusive categories, a similar pattern was observed. After very few differences were found at the Grade 8 level, it was found that more statistically significant differences emerged in Grade 9, with fewer being found in the subsequent grades. Taylor (1996) found that statistically significant differences existed in each of the mutually exclusive categories. The sample in Taylor (1996) was a much larger sample and the study was performed over a period of ten years, resulting in a much larger number of questions that could be analysed. This is not to say that the results in this study are insignificant - it merely says that the results should be interpreted with care.

- As with the Mutually Exclusive Categories, Taylor (1996) found that the males outperformed the females in each of the Special Categories. The largest difference was found in the Mechanics category and the smallest difference was found in the three dimensional Geometry (without a diagram) category (Taylor, 1996). In this study, the categories in which there were the largest number of questions are most likely to give results which are more easily interpreted. These categories were Enumeration and two dimensional Geometry (with diagram). Once again the pattern that emerged was similar to that which was observed in the Mutually Exclusive Categories. The males tended to perform better than the females on those questions which required a greater spatial ability (two dimensional Geometry - with or without a diagram provided). The three dimensional Geometry results are based on very few questions, although it is encouraging that there were very few, if any, statistically significant differences found on these questions.
- The results of the analysis on the questions that were repeated in more than one grade provided some interesting insights into the type of questions that resulted in improved performance with increasing maturity in mathematics (which is the expected result on all questions) and those questions on which improvement did not occur, yet gender related statistically significant differences were recorded. The majority of those questions whose differential results were apparently due to gender only required the use of some spatial skills in order to solve the corresponding problems.

Attitudes

From the results of the investigations into the attitudes of the candidates in the University of Cape Town Mathematics Competition, a number of patterns emerged:

- The males taking part in the competition seemed to stereotype mathematics as a male domain more often than did the females. In fact, the females seemed almost unanimous in their agreement that women, quite rightly, have their place in mathematics and that their ability equals that of males. This attitude reflects that which has been reported in the literature survey in that males consistently exhibit more stereotyped attitudes towards mathematics. The causes of these attitudes could include the external influences of parents, teachers and the public (popular) image that mathematics is accorded. The learners' (whether male or female) attitude towards mathematics as a male domain did not correlate significantly with overall performance in the mathematics competition.
- The confidence levels of the candidates appear to be different in that statistically significant differences in the items (originally placed in the confidence subscale) have been found. Owing to the nature of the sample being investigated, it is not surprising that, although statistically significant differences in confidence levels have been found, closer examination of the data reveals that both the males and the females are reasonably confident in their ability in mathematics. For both the males and the females, confidence in ability in mathematics displayed significant correlation with performance in mathematics, which seems to be consistent with the results reported in the literature survey. Hart (1989) found that there was a significantly positive correlation between confidence and performance in mathematics. It was also found in that study that there was no significant difference by gender or by confidence level of students engaging in

high level mathematical activities (Hart, 1989).

- With regard to the motivation scale, it was found that the males and the femalesd tended to exhibit very similar attitudes towards motivation in mathematics. As with the confidence scale, it should be expected that the candidates taking part in the University of Cape Town Mathematics Competition are motivated about taking part in mathematical activities and would also be strongly motivated about using mathematics in their future careers. Since the correlation coefficients of the motivation items with overall score were not statistically significant, the indication is that all the students taking part in the mathematics competition are reasonably well motivated to achieve and to take part in mathematics.
- All the learners seemed to perceive mathematics as being useful and would be willing to use mathematics in their future careers. It has been found that such a perception is strongly connected to participation and achievement in mathematics.
- Typically the correlation coefficients of attitudinal items and overall scores range between 0,17 and 0,5 in absolute value, and at this level are deemed statistically significant. These results are, however, not necessarily practically significant, since the relationship is not particularly strong. A comparison of the correlation coefficients for the males and the females indicates that there are no significant differences in the patterns in the relationships between attitude and performance. This conclusion is supported by the meta-analysis conducted by Ma and Kishor (1997).

Are these observed differences *educationally significant*?

Performance

Much has been said in the literature and in this study about statistically significant gender related differences in performance in mathematics. The techniques and tests used to determine whether these differences were significant are often very powerful tests. What determines whether an apparent difference is statistically significant or not is the number of observations that have been made and the more obvious one of the actual difference involved. The more observations that have been made, the more sensitive is the test to detecting a statistically significant difference. Thus, often the results that are reported as being statistically significant are actually very small differences in reality.

The question being asked is: should educators be concerned about these reported gender related differences in performance in mathematics? In other words, are these differences educationally significant? I will attempt to answer this question within the context of South Africa. In this country, the majority of children of school going age have received a particularly disadvantaged education. It is only in very recent times that this problem has been addressed and it will take more than one generation for this inequity in education to be resolved. Thus, the problems being faced in this country extend far beyond whether these gender related differences exist. Some of the major problems facing education in this country include:

- The language of instruction is often not the home language of the learner. Thus the learner has to cope with a different language, as well as learning new concepts via a "foreign" language.
- A large number of high school (and primary school) educators are not

adequately prepared to teach the subject matter.

- The curriculum and textbooks have, in the past, not been adequate in addressing the problems of the disadvantaged education received by the majority.
- In the majority of schools, there has not been an acceptable "culture of learning and teaching", resulting in an inadequate education being received by those learners. Such a "culture of learning" will take many years to alter, since it has been part of the legacy inherited by the current education system in this country.

It is thus my conclusion that while these gender related differences do exist, they are not necessarily educationally significant. This is not to say that such differences should not be addressed, but that they should be seen in the context of the wider education of the learners. In the development of a new curriculum for education in South Africa, all inequities in education should be addressed including those of the perceived gender differences.

Attitudes

Unlike the apparent educational insignificance of the gender related differences in performance in mathematics, it is felt that the gender related differences in attitudes are educationally significant. Such attitudes can be affected and potentially altered by informed and sensitive educators. It is important for all educators to realise that they have the potential to influence the attitudes of their pupils and that they should attempt to do so in a positive, informed manner. It is not necessary for the new curriculum to be implemented for a change in the general attitude of the school-going population to be brought about, but such problems can be addressed on an ongoing basis by all the educators.

Suggestions for further study

As an extension of this study, it is suggested that a similar analysis be performed on the data obtained by selecting only those students in the top 150 in each grade. This might help clarify the reasons behind the relatively large numbers of males compared to females appearing at the upper end of the ability scale.

It is also in this area that qualitative research methods could be applied in the form of interviews and analysis of problem solving of questions requiring long answers. This could provide valuable insight into the actual *processes* used by the learners and could thus help in the identification of gender related differences in approach and techniques used by the learners.

A further study could be done in which the *type* of school (i.e., single-sex or coeducational) that the learner attends is taken into account. In this way a comparison can be made of the relative performance of the members of each school type, resulting in a four way comparison. In terms of this study, observation of the actual classes could provide the researcher with some insight into the idea that boys and girls receive differential treatment in class, and as a result of this treatment, their performance in and attitudes towards mathematics are directly affected.

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ADDENDUM A

The University of Cape Town Mathematics Competition Question Papers

Item Analysis

Graph of Performance of Individuals and Pairs

STANDARD 6/STANDERD 6

1. Which is the largest of the following numbers?

   Watter een van die volgende getalle is die grootste?

   (1) 0,303 (2) 0,330 (3) 0,3 (4) 0,312 (5) 0,3003

2. Lara bought seven Choc Bars at R1.32 each. How much change did she get from a R20 note?

   Lara het sewe Choc Bars teen R1.32 elk gekoop. Hoeveel kleingeld het sy gekry toe sy met 'n R20-noot betaal het?

   (1) R9.24 (2) R0.76 (3) R10.76 (4) R18.68 (5) R10.86

3. Which number is halfway between 179 and 837?

   Watter getal is halfpad tussen 179 en 837?

   (1) 453 (2) 458 (3) 503 (4) 508 (5) 509

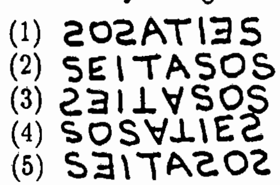
4. What is 75% of 72?

   Wat is 75% van 72?

   (1) 18 (2) 36 (3) 48 (4) 54 (5) 96

5. Allie painted SOSATIES on the window of his Corner Cafe. Viewed from the other side, what does it look like?

   Allie het SOSATIES op die venster van sy Hoek Kafee geverf. Hoe lyk dit gesien vanaf die ander kant?

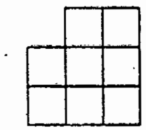


6. On my calculator $\frac{1}{3} = 0.3333333$. What would $\frac{1}{30}$ be?

   Volgens my sakrekenaar is $\frac{1}{3} = 0.3333333$. Wat sou $\frac{1}{30}$ wees?

   (1) 3.3333333 (2) 0.3030303 (3) 0.3333333 (4) 0.0303030 (5) 0.0333333

7. How many squares are there altogether in this diagram?



   Hoeveel vierkante is daar altesaam in hierdie diagram?

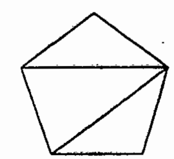
   (1) 9 (2) 10 (3) 11 (4) 12 (5) 13

8. Linda writes down all the whole numbers from 2 to 21. What percentage of whole numbers on the list are multiples of 4?

   Linda skryf al die heelgetalle vanaf 2 tot 21 neer. Watter persentasie van hierdie heelgetalle is veelvoude van 4?

   (1) 25 (2) 21 (3) 20 (4) 26 (5) 24

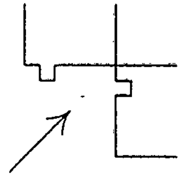
9. The diagram shows a regular pentagon with two of its diagonals. If all of its diagonals are drawn, into how many regions will the pentagon be divided?



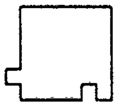
   Die figuur toon 'n reëlmatige vyfhoek met twee van sy hoeklyne. As al sy hoeklyne getrek word, in hoeveel gebiede sal die vyfhoek verdeel wees?

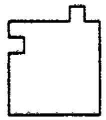
   (1) 4 (2) 5 (3) 8 (4) 10 (5) 11

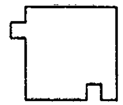
10. Which of the pieces fits into the space shown?

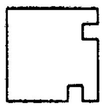


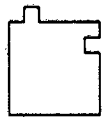
Watter legkaartstuk pas in die aangeduide posisie?

(1) 

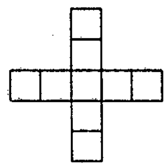
(2) 

(3) 

(4) 

(5) 

11. The numbers 2, 4, 6, 7, 8, 10, 12, 14 and 20 are put into the nine squares so that the horizontal and vertical lines both add up to 45.



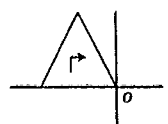
Which number must be put in the middle square?

Die getalle 2, 4, 6, 7, 8, 10, 12, 14 en 20 word sodanig in die nege vierkante geplaas sodat die som van die getalle op die horisontale lyn en dié op die vertikale lyn beide 45 is.

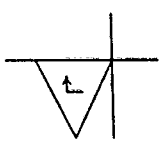
Watter getal moet in die middelste vierkant geplaas word?

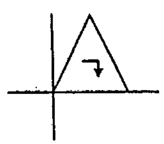
(1) 6 (2) 7 (3) 8 (4) 10 (5) 12

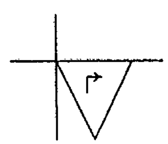
12. The triangle shown is rotated 180° about O. What is the outcome?

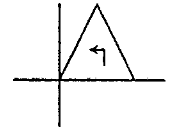


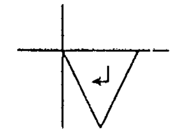
Die driehoek getoon word deur 180° gedraai om punt O. Wat is die resultaat?

(1) 

(2) 

(3) 

(4) 

(5) 

13. When $2371 \times 9543 \times 6877 \times 5609$ is divided by 10, the remainder is

As $2371 \times 9543 \times 6877 \times 5609$ deur 10 gedeel word, is die res

(1) 1 (2) 3 (3) 5 (4) 7 (5) 9

14. Ann has a 1c, a 2c, a 5c and a 10c coin. What is the total number of non-zero amounts of money which can be obtained from some or all of these coins?

Annie het 'n 1-sent, 'n 2-sent, 'n 5-sent en 'n 10-sent muntstuk. Wat is die totale aantal nie-nul bedrae geld wat uit een of meer van hierdie muntstukke gekry kan word?

(1) 4 (2) 15 (3) 18 (4) 24 (5) 16

15. Nine bus stops are equally spaced along a bus route. The distance from the first to the third is 600m. How far is it from the first to the ninth?

Nege bushaltes is gelyk gespasiëer op 'n busroete. Die afstand van die eerste tot by die derde is 600m. Hoe ver is dit van die eerste tot by die negende?

(1) 600m (2) 1600m (3) 1800m (4) 2400m (5) 2700m

16. If $p \otimes q$ means $3p + q^2$, then $(3 \otimes 4) \otimes 5$ is equal to

As $p \otimes q$ beteken $3p + q^2$, dan is $(3 \otimes 4) \otimes 5$ gelyk aan

(1) 60 (2) 100 (3) 87 (4) 72 (5) 91

17. In the multiplication shown, S and T are different digits between 1 and 9. The value of $S+T$ is

$$\begin{array}{rrrr} & & S & 6 \\ & \times & 2 & T \\ \hline 2 & 1 & 5 & 0 \end{array}$$

In die vermenigvuldiging getoon is S en T verskillende syfers tussen 1 en 9. Die waarde van $S+T$ is dus

(1) 13 (2) 14 (3) 15 (4) 16 (5) 17

18. How many digits are there in 5^8?

Hoeveel syfers is daar in 5^8?

(1) 2 (2) 5 (3) 6 (4) 8 (5) 40

19. What is the minimum number of circular discs of the same size required to completely cover another disc of the same size so that any disc may touch, but not overlap, the centre of the covered disc when viewed from above?

Wat is die minimum aantal sirkelvormige skywe van dieselfde grootte wat benodig word om nog 'n skyf van dieselfde grootte heeltemal te bedek, op so 'n manier dat enige skyf (soos van bo af gesien) aan die middelpunt van die bedekte skyf mag raak, maar dit nie mag oordek nie?

(1) 6 (2) 4 (3) 3 (4) 2 (5) 5

20. Anna likes to drink a mixture of fruit juice and lemonade. One day she half filled a glass with fruit juice, then filled it with lemonade. After mixing the two liquids thoroughly, she drank one-third of the amount, and then again filled the glass with lemonade. What fraction of this mixture was fruit juice?

Anna hou daarvan om 'n mengsel van vrugtesap en limonade te drink. Eendag het sy 'n glas halfpad gevul met vrugtesap, en dit daarna volgemaak met limonade. Nadat sy die twee vloeistowwe deeglik gemeng het, het sy een-derde van die inhoud gedrink en daarna die glas weer volgemaak met limonade. Watter breuk van hierdie mengsel was toe vrugtesap?

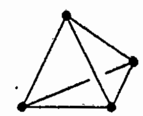
(1) $\frac{1}{6}$ (2) $\frac{1}{3}$ (3) $\frac{1}{2}$ (4) $\frac{3}{4}$ (5) $\frac{5}{6}$

21. If I write one digit per second, how long will it take to write out all the numbers from 1 to 1997?

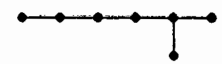
As ek teen 'n spoed van een syfer per sekonde skryf, hoe lank sal dit my neem om al die getalle vanaf 1 tot 1997 uit te skryf?

(1) 1 hr/uur 57 min 23 sec/sek (2) 1 hr/uur 54 min 41 sec/sek
(3) 1 hr/uur 55 min 52 sec/sek (4) 1 hr/uur 53 min 17 sec/sek
(5) 1 hr/uur 56 min 11 sec/sek

22. Six rods of equal length are joined together loosely at their ends, in five different ways, as shown below. Which of the linkages *cannot* be formed into a tetrahedron by joining rods together at their ends?



Ses stokkies van gelyke lengte word losweg aan mekaar gekoppel by hul ente, op vyf verskillende maniere, soos hieronder getoon. Watter een van die koppelings *kan nie* omvorm word in 'n viervlak (tetraëder) deur stokkies by hul ente aan mekaar te koppel nie ?

(1)  (2)  (3) 

(4)  (5) 

23. What angle is formed by the hands of a clock at 24 minutes past 11?

Wat is die grootte van die hoek wat gevorm word deur die wysers van 'n horlosie om 24 minute oor 11?

(1) 150° (2) 169° (3) 170° (4) 162° (5) 180°

24. At the end of 1995 the average rainfall in my town for the ten-year period just ended was 631 mm. A year later the ten-year average was 601 mm, after 450 mm had fallen in 1996. What was the rainfall in 1986? (Answer in millimetres)

Aan die einde van 1995 was die gemiddelde reënval in my dorp 631 mm vir die tien-jaar periode wat toe geëindig het. 'n Jaar later was die tien-jaar gemiddelde 601 mm, nadat daar 450 mm in 1996 geval het. Wat was die reënval in 1986? (Antwoord in millimeters)

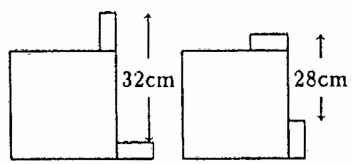
(1) 750 (2) 616 (3) 1232 (4) 30 (5) 480

25. What is the last digit of 3^{1997}?

Wat is die laaste syfer van 3^{1997}?

(1) 1 (2) 3 (3) 5 (4) 7 (5) 9

26. A large box and two identical small bricks are arranged in two ways, as shown. How high is the box?



'n Groot karton en twee eenderse klein bakstene word op twee maniere gerangskik, soos getoon. Hoe hoog is die karton?

(1) 28 cm (2) 29 cm (3) 30 cm (4) 31 cm (5) 32 cm

27. The number of positive numbers less than 1000 with the sum of their digits equal to 6 is

Die aantal positiewe getalle kleiner as 1000, waarvan die som van hulle syfers gelyk aan 6 is, is

(1) 20 (2) 28 (3) 36 (4) 48 (5) 60

28. John had three $3 \times 3 \times 3$ wooden cubes. He painted one side of one cube, two sides of the second cube and three sides of the third cube: all red. He then cut each cube into 27 small $1 \times 1 \times 1$ cubes, and counted the small cubes which had no painted sides.

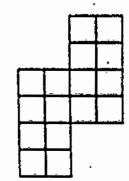
Which of the following totals could he *not* have obtained?

Jan het drie $3 \times 3 \times 3$ hout-kubusse. Hy verf een sykant van een kubus, twee sykante van die tweede kubus en drie sykante van die derde kubus: almal rooi. Hierna sny hy elke kubus in 27 klein $1 \times 1 \times 1$ kubussies. Hy tel die aantal klein kubussies met geen geverfde kante nie.

Watter een van die volgende totale sou hy *nie* kon kry nie?

(1) 33 (2) 34 (3) 35 (4) 36 (5) 38

29. From a sheet of sixteen stamps as shown, the number of ways of choosing 3 connected stamps is



Uit 'n vel van sestien seëls soos getoon, is die aantal maniere om 3 seëls wat aan mekaar vas is te kies

(1) 41 (2) 40 (3) 42 (4) 35 (5) 44

30. Bud the Spud had a summer job on a farm. He had four bags of potatoes to weigh but each bag weighed less than 100 kg and the scale only weighed in excess of 100 kg. He solved the problem by weighing the bags two at a time. He found the weighings to be 103, 105, 106, 106, 107 and 109 kilograms. The weight of the lightest bag, in kilograms, was

Piet Patat het vakansiewerk op 'n plaas gedoen. Hy moes vier sakke aartappels weeg, maar elke sak het minder as 100 kg geweeg, terwyl die skaal slegs gewigte van meer as 100 kg kon weeg. Hy het die probleem opgelos deur die sakke twee op 'n slag te weeg. Die gewigte was 103, 105, 106, 106, 107 en 109 kilogram. Die gewig van die ligste sak, in kilogram, was

(1) 50 (2) 51 (3) 49 (4) 52 (5) 48

Standard 6

Question		1	2	3	4	5	Abstain
1	Individual	0	[73]	18	0	7	1
	Pairs	0	[74]	20	1	4	1
2	Individual	7	2	[70]	17	3	2
	Pairs	6	2	[80]	9	3	1
3	Individual	6	9	8	[57]	3	17
	Pairs	2	8	7	[65]	2	16
4	Individual	7	1	5	[77]	3	8
	Pairs	5	2	4	[83]	1	5
5	Individual	11	13	4	1	[71]	1
	Pairs	7	9	2	3	[78]	1
6	Individual	4	15	6	20	[51]	4
	Pairs	2	15	3	15	[58]	7
7	Individual	7	2	[79]	6	2	5
	Pairs	4	0	[92]	2	0	2
8	Individual	[51]	2	24	5	6	12
	Pairs	[56]	4	23	5	6	7
9	Individual	3	20	9	7	[56]	5
	Pairs	3	20	7	3	[64]	4
10	Individual	[90]	5	3	1	1	1
	Pairs	[95]	2	2	0	0	0
11	Individual	5	[46]	10	5	3	32
	Pairs	4	[59]	6	4	3	24
12	Individual	8	16	2	4	[60]	9
	Pairs	9	11	2	6	[69]	3
13	Individual	7	7	3	4	[43]	35
	Pairs	7	6	8	7	[46]	26
14	Individual	5	[35]	29	3	3	24
	Pairs	6	[33]	33	4	5	18
15	Individual	0	4	45	[42]	7	2
	Pairs	0	4	46	[40]	7	2

Question		1	2	3	4	5	Abstain
16	Individual	20	[37]	3	7	1	32
	Pairs	27	[35]	3	6	2	28
17	Individual	[29]	6	9	7	4	45
	Pairs	[40]	8	11	5	3	33
18	Individual	10	10	[31]	33	7	8
	Pairs	4	8	[44]	34	7	4
19	Individual	10	21	[16]	16	11	26
	Pairs	9	23	[21]	14	6	27
20	Individual	22	[50]	10	6	6	7
	Pairs	22	[57]	7	3	8	4
21	Individual	9	[11]	6	23	6	45
	Pairs	9	[9]	7	26	6	42
22	Individual	8	9	17	[13]	23	30
	Pairs	11	4	22	[11]	28	24
23	Individual	11	11	20	[16]	30	13
	Pairs	9	16	26	[13]	28	8
24	Individual	[14]	15	9	8	14	41
	Pairs	[11]	15	10	9	19	37
25	Individual	19	[19]	4	24	11	23
	Pairs	23	[22]	6	22	9	18
26	Individual	15	8	[46]	3	7	20
	Pairs	9	9	[49]	3	10	20
27	Individual	7	[14]	10	4	22	43
	Pairs	9	[15]	12	9	21	34
28	Individual	15	[8]	8	11	14	45
	Pairs	15	[10]	11	11	10	43
29	Individual	3	16	[17]	26	8	30
	Pairs	4	15	[20]	21	11	29
30	Individual	7	[28]	10	9	13	34
	Pairs	5	[34]	11	12	14	23

STANDARD 7/STANDERD 7

1. Which is the largest of the following numbers?

   Watter een van die volgende getalle is die grootste?

   (1) 0, 303 (2) 0, 330 (3) 0, 3 (4) 0, 312 (5) 0, 3003

2. $\frac{1}{4} + \frac{1}{6}$ is equal to/is gelyk aan

   (1) $\frac{1}{5}$ (2) $\frac{2}{5}$ (3) $\frac{1}{24}$ (4) $\frac{1}{10}$ (5) $\frac{5}{12}$

3. $(7a + 5b) - (5a - 7b)$ is equal to/is gelyk aan

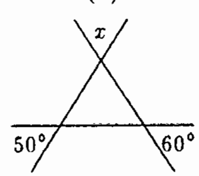
   (1) $12a - 12b$ (2) $2a - 2b$ (3) 0 (4) $2a + 12b$ (5) $12a - 2b$

4. What is 75% of 72?

   Wat is 75% van 72?

   (1) 18 (2) 36 (3) 48 (4) 54 (5) 96

5. In the figure, x is equal to



   In die figuur is x gelyk aan

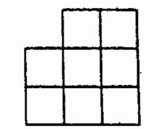
   (1) 50° (2) 60° (3) 70° (4) 110° (5) 65°

6. On my calculator $\frac{1}{3} = 0.3333333$. What would $\frac{1}{30}$ be?

   Volgens my sakrekenaar is $\frac{1}{3} = 0.3333333$. Wat sou $\frac{1}{30}$ wees?

   (1) 3.3333333 (2) 0.3030303 (3) 0.3333333 (4) 0.0303030
   (5) 0.0333333

7. How many squares are there altogether in this diagram?



   Hoeveel vierkante is daar altesaam in hierdie diagram?

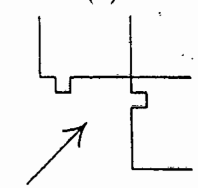
   (1) 9 (2) 10 (3) 11 (4) 12 (5) 13

8. Linda writes down all the whole numbers from 2 to 21. What percentage of whole numbers on the list are multiples of 4?

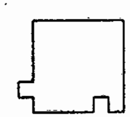
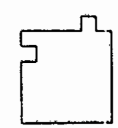
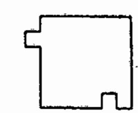
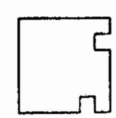
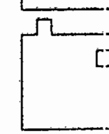
   Linda skryf al die heelgetalle vanaf 2 tot 21 neer. Watter persentasie van hierdie heelgetalle is veelvoude van 4?

   (1) 25 (2) 21 (3) 20 (4) 26 (5) 24

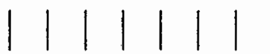
9. Which of the pieces fits into the space shown?



   Watter legkaartstuk pas in die aangeduide posisie?

   (1) 
   (2) 
   (3) 
   (4) 
   (5) 

10. An embroidery pattern looks like this on the right side. The wrong side could look like



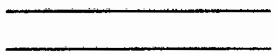
'n Borduurwerkpatroon lyk soos volg aan die regte kant. Die verkeerde kant lyk soos

(1) 

(2)

(3) 

(4) 

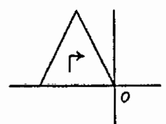
(5) 

11. The value of 4×2^{1997} is

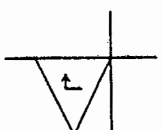
Die waarde van 4×2^{1997} is

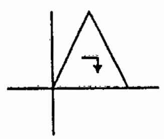
(1) 4^{1998} (2) 8^{1997} (3) 2^{1999} (4) 2^{3994} (5) 4^{3994}

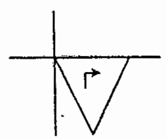
12. The triangle shown is rotated 180° about O. What is the outcome?

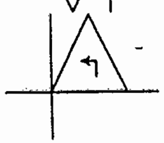


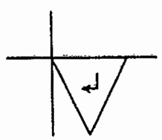
Die driehoek getoon word deur 180° gedraai om punt O. Wat is die resultaat?

(1) 

(2) 

(3) 

(4) 

(5) 

Standard 7/Standerd 7

13. Nine bus stops are equally spaced along a bus route. The distance from the first to the third is 600m. How far is it from the first to the ninth?

Nege bushaltes is gelyk gespasiëer op 'n busroete. Die afstand van die eerste tot by die derde is 600m. Hoe ver is dit van die eerste tot by die negende?

(1) 600m (2) 1600m (3) 1800m (4) 2400m (5) 2700m

14. If $p \otimes q$ means $3p + q^2$, then $(3 \otimes 4) \otimes 5$ is equal to

As $p \otimes q$ beteken $3p + q^2$, dan is $(3 \otimes 4) \otimes 5$ gelyk aan

(1) 60 (2) 100 (3) 87 (4) 72 (5) 91

15. What is the minimum number of circular discs of the same size required to completely cover another disc of the same size so that any disc may touch, but not overlap, the centre of the covered disc when viewed from above?

Wat is die minimum aantal sirkelvormige skywe van dieselfde grootte wat benodig word om nog 'n skyf van dieselfde grootte heeltemal te bedek, op so 'n manier dat enige skyf (soos van bo af gesien) aan die middelpunt van die bedekte skyf mag raak, maar dit nie mag oordek nie?

(1) 6 (2) 4 (3) 3 (4) 2 (5) 5

16. Two dice are rolled. What is the probability that the sum of the numbers shown is odd?

Twee dobbelstene word gegooi. Wat is die waarskynlikheid dat die som van die getalle getoon onewe is?

(1) $\frac{1}{6}$ (2) $\frac{1}{9}$ (3) $\frac{1}{4}$ (4) $\frac{2}{3}$ (5) $\frac{1}{2}$

17. A group of dogs and children are playing together. I count 12 heads and 44 legs altogether. How many dogs are there?

'n Groep honde en kinders speel saam. Ek tel altesame 12 koppe en 44 bene. Hoeveel honde is daar?

(1) 2 (2) 4 (3) 6 (4) 8 (5) 10

18. Thabo has written ten maths tests this year and his average mark is 68. What mark must he get in the next test to raise his average to 70?

Thabo het tien wiskunde toetse hierdie jaar geskryf en sy gemiddelde punt is 68. Watter punt moet hy in die volgende toets behaal sodat sy gemiddelde na 70 kan styg?

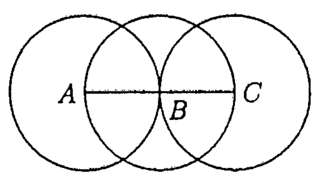
(1) 70 (2) 72 (3) 78 (4) 88 (5) 90

19. A cube of side 4 cm is made up of 64 small 1 cm cubes. How many of these 1 cm cubes are face-to-face with exactly four other 1 cm cubes?

'n Kubus met 'n sykant van 4 cm is opgebou uit 64 klein 1 cm-kubussies. Hoeveel van hierdie 1 cm-kubussies raak gesig-aan-gesig met presies 4 ander 1 cm-kubussies?

(1) 6 (2) 8 (3) 16 (4) 24 (5) 28

20. In the diagram, A, B and C are the centres of the three circles, each of radius r.



A beetle starts at A and has to walk along every line in the diagram at least once. What is the shortest distance it has to travel?

In die figuur is A, B en C die middelpunte van die drie sirkels, elk met radius r.

Standard 7/Standerd 7

'n Gogga begin by A. Dit moet ten minste een keer langs elke lyn in die diagram loop. Wat is die kortste afstand wat dit moet loop?

(1) $2\pi r^2 + 2r$ (2) $6\pi r + 2r$ (3) $4\pi r$ (4) $6\pi r$ (5) $14r^2$

21. A fence runs north-south. A bird leaves its position P on the fence and flies due north for one kilometre, then west for two kilometres, then due north again for half a kilometre. Finally it flies south-east. The point at which it crosses the line of the fence is

'n Heining loop noord-suid. 'n Voël verlaat sy posisie P op die heining en vlieg reg noord vir een kilometer, dan wes vir twee kilometers, dan weer reg noord vir 'n halwe kilometer. Uiteindelik vlieg dit suid-oos. Die punt waar hy die lyn van die heining oorsteek is

(1) at P / by P
(2) half a kilometre south of P / 'n halwe kilometer suid van P
(3) half a kilometre north of P / 'n halwe kilometer noord van P
(4) one kilometre south of P / een kilometer suid van P
(5) two and a half kilometres north of P / twee en 'n half kilometers noord van P

22. What angle is formed by the hands of a clock at 24 minutes past 11?

Wat is die grootte van die hoek wat gevorm word deur die wysers van 'n horlosie om 24 minute oor 11?

(1) 150° (2) 169° (3) 170° (4) 162° (5) 180°

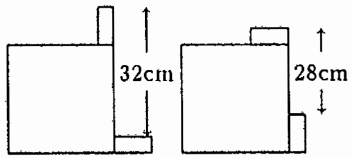
23. If $\frac{1}{a} = \frac{1}{b} - \frac{1}{c}$ then c equals

As $\frac{1}{a} = \frac{1}{b} - \frac{1}{c}$ dan is c gelyk aan

(1) $\frac{1-b}{ab}$ (2) $\frac{ab}{a-b}$ (3) $a-b$ (4) $\frac{1}{a}-\frac{1}{b}$ (5) $\frac{a-ab}{b}$

24. A large box and two identical small bricks are arranged in two ways, as shown. How high is the box?

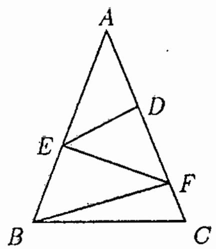
'n Groot karton en twee eenderse klein bakstene word op twee maniere gerangskik, soos getoon. Hoe hoog is die karton?



(1) 28 cm (2) 29 cm (3) 30 cm (4) 31 cm (5) 32 cm

25. In the figure, $AB = AC$ and $AD = DE = EF = FB = BC$. The size of $\angle DEF$ is

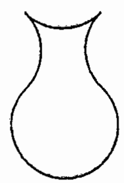
In die figuur is $AB = AC$ en $AD = DE = EF = FB = BC$. Die grootte van $\angle DEF$ is



(1) 70° (2) 80° (3) 90° (4) 100° (5) 120°

26. The shape shown is made from three quarter circles and one three-quarter circle, all of radius r. What is the area of the figure?

Die figuur getoon is gemaak van drie kwartsirkels en een driekwartsirkel, elk met 'n radius r. Wat is die oppervlakte van die figuur?



(1) $4r^2$ (2) $(\pi+1)r^2$ (3) $\frac{3\pi r^2}{2}$ (4) $\sqrt{2}\pi r^2$ (5) $2\pi r^2$

27. John had three $3 \times 3 \times 3$ wooden cubes. He painted one side of one cube, two sides of the second cube and three sides of the third cube: all red. He then cut each cube into 27 small $1 \times 1 \times 1$ cubes, and counted the small cubes which had no painted sides.

Which of the following totals could he *not* have obtained?

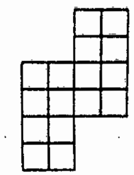
Jan het drie $3 \times 3 \times 3$ hout-kubusse. Hy verf een sykant van een kubus, twee sykante van die tweede kubus en drie sykante van die derde kubus: almal rooi. Hierna sny hy elke kubus in 27 klein $1 \times 1 \times 1$ kubussies. Hy tel die aantal klein kubussies met geen geverfde kante nie.

Watter een van die volgende totale sou hy *nie* kon kry nie?

(1) 33 (2) 34 (3) 35 (4) 36 (5) 38

28. From a sheet of sixteen stamps as shown, the number of ways of choosing 3 connected stamps is

Uit 'n vel van sestien seëls soos getoon, is die aantal maniere om 3 seëls wat aan mekaar vas is te kies



(1) 41 (2) 40 (3) 42 (4) 35 (5) 44

29. The unit digit of $3^{1997} + 4^{1997} + 5^{1997} + 6^{1997}$ is

Die ene syfer van $3^{1997} + 4^{1997} + 5^{1997} + 6^{1997}$ is

(1) 0 (2) 2 (3) 6 (4) 4 (5) 8

30. Bud the Spud had a summer job on a farm. He had four bags of potatoes to weigh but each bag weighed less than 100 kg and the scale only weighed in excess of 100 kg. He solved the problem by weighing the bags two at a time. He found the weighings to be 103, 105, 106, 106, 107 and 109 kilograms. The weight of the lightest bag, in kilograms, was

Piet Patat het vakansiewerk op 'n plaas gedoen. Hy moes vier sakke aartappels weeg, maar elke sak het minder as 100 kg geweeg, terwyl die skaal slegs gewigte van meer as 100 kg kon weeg. Hy het die probleem opgelos deur die sakke twee op 'n slag te weeg. Die gewigte was 103, 105, 106, 106, 107 en 109 kilogram. Die gewig van die ligste sak, in kilogram, was

(1) 50 (2) 51 (3) 49 (4) 52 (5) 48

Standard 7

Question		1	2	3	4	5	Abstain
1	Individual	0	[75]	19	1	4	1
	Pairs	0	[73]	24	0	2	0
2	Individual	2	0	5	7	[85]	1
	Pairs	2	0	4	5	[89]	0
3	Individual	5	22	3	[60]	8	2
	Pairs	4	22	1	[63]	9	2
4	Individual	5	2	4	[82]	3	5
	Pairs	4	1	4	[84]	1	6
5	Individual	1	2	[91]	4	0	2
	Pairs	1	1	[92]	5	0	1
6	Individual	2	16	2	21	[52]	8
	Pairs	6	19	1	16	[51]	6
7	Individual	4	2	[86]	5	1	2
	Pairs	3	1	[90]	4	1	1
8	Individual	[60]	2	19	5	4	9
	Pairs	[59]	2	23	5	2	7
9	Individual	[91]	3	2	1	2	1
	Pairs	[95]	2	2	0	0	1
10	Individual	42	4	[38]	7	1	7
	Pairs	51	4	[33]	6	2	5
11	Individual	2	52	[26]	3	3	14
	Pairs	2	60	[16]	3	5	14
12	Individual	7	8	3	2	[73]	6
	Pairs	5	13	2	4	[73]	3
13	Individual	1	4	32	[59]	4	1
	Pairs	0	2	40	[52]	6	1
14	Individual	11	[52]	3	3	2	29
	Pairs	18	[45]	3	2	1	31
15	Individual	6	27	[22]	15	5	26
	Pairs	10	20	[22]	19	4	25

Question		1	2	3	4	5	Abstain
16	Individual	8	7	11	10	[49]	15
	Pairs	9	8	9	9	[52]	13
17	Individual	1	4	4	7	[75]	9
	Pairs	0	2	5	7	[83]	4
18	Individual	4	29	7	6	[40]	14
	Pairs	5	42	7	6	[26]	15
19	Individual	3	20	29	[21]	5	22
	Pairs	3	17	40	[17]	4	20
20	Individual	6	[42]	7	4	3	38
	Pairs	6	[40]	10	10	2	32
21	Individual	36	[25]	14	9	4	13
	Pairs	40	[21]	15	10	7	7
22	Individual	7	10	23	[27]	22	11
	Pairs	11	15	27	[18]	22	7
23	Individual	5	[16]	16	23	3	37
	Pairs	5	[11]	16	38	4	26
24	Individual	10	7	[53]	4	6	20
	Pairs	11	6	[58]	5	7	12
25	Individual	30	10	11	[5]	4	40
	Pairs	38	7	11	[6]	7	31
26	Individual	[8]	5	36	5	6	41
	Pairs	[9]	7	37	5	5	37
27	Individual	10	[8]	7	10	16	49
	Pairs	13	[7]	10	11	10	49
28	Individual	1	22	[19]	24	9	25
	Pairs	4	15	[23]	25	11	23
29	Individual	6	8	11	9	[22]	44
	Pairs	11	6	10	13	[23]	37
30	Individual	7	[34]	7	9	10	34
	Pairs	6	[35]	8	9	11	32

STANDARD 8/STANDERD 8

1. $\frac{1}{4}+\frac{1}{6}$ is equal to/is gelyk aan

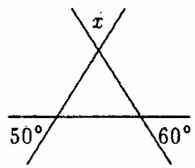
   (1) $\frac{1}{5}$ (2) $\frac{2}{5}$ (3) $\frac{1}{24}$ (4) $\frac{1}{10}$ (5) $\frac{5}{12}$

2. What is 75% of 72?

   Wat is 75% van 72?

   (1) 18 (2) 36 (3) 48 (4) 54 (5) 96

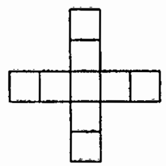
3. In the figure, x is equal to

   In die figuur is x gelyk aan

   (1) 50° (2) 60° (3) 70° (4) 110° (5) 65°

4. The numbers 2, 4, 6, 7, 8, 10, 12, 14 and 20 are put into the nine squares so that the horizontal and vertical lines both add up to 45.

   Which number must be put in the middle square?

   Die getalle 2, 4, 6, 7, 8, 10, 12, 14 en 20 word sodanig in die nege vierkante geplaas sodat die som van die getalle op die horisontale lyn en dié op die vertikale lyn beide 45 is.

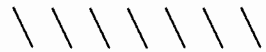
   Watter getal moet in die middelste vierkant geplaas word?

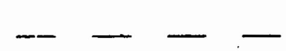
   (1) 6 (2) 7 (3) 8 (4) 10 (5) 12

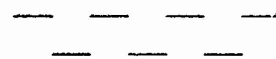
5. An embroidery pattern looks like this on the right side. The wrong side could look like

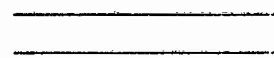
'n Borduurwerkpatroon lyk soos volg aan die regte kant. Die verkeerde kant lyk soos

(1) 

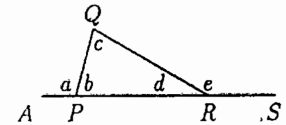
(2) 

(3) 

(4) 

(5) 

6. In the diagram, $PR = QR$. The value of a is

   In die figuur is $PR = QR$. Die waarde van a is

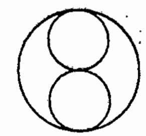
   (1) $b+e$ (2) $c+e$ (3) $180° - d$ (4) $180° - e + b$
   (5) $180° - c + d$

7. The value of 4×2^{1997} is

   Die waarde van 4×2^{1997} is

   (1) 4^{1998} (2) 8^{1997} (3) 2^{1999} (4) 2^{3994} (5) 4^{3994}

8. In the diagram, the two small circles are equal and tangent to each other and tangent to the large circle. The ratio of the shaded area to the area of the large circle is

   In die figuur is die twee klein sirkels gelyk, asook raaklynig aan mekaar en aan die groot sirkel. Die verhouding van die verdonkerde oppervlakte tot die oppervlakte van die groot sirkel is

   (1) 1 : 2 (2) 1 : 3 (3) 1 : 4 (4) 2 : 3 (5) 2 : 5

9. If $p \otimes q$ means $3p + q^2$, then $(3 \otimes 4) \otimes 5$ is equal to

As $p \otimes q$ beteken $3p + q^2$, dan is $(3 \otimes 4) \otimes 5$ gelyk aan

(1) 60 (2) 100 (3) 87 (4) 72 (5) 91

10. What is the minimum number of circular discs of the same size required to completely cover another disc of the same size so that any disc may touch, but not overlap, the centre of the covered disc when viewed from above?

Wat is die minimum aantal sirkelvormige skywe van dieselfde grootte wat benodig word om nog 'n skyf van dieselfde grootte heeltemal te bedek, op so 'n manier dat enige skyf (soos van bo af gesien) aan die middelpunt van die bedekte skyf mag raak, maar dit nie mag oordek nie?

(1) 6 (2) 4 (3) 3 (4) 2 (5) 5

11. There is only one prime number between 50 and 90 whose reversal (the number obtained by writing its digits in reverse order) is also a prime number, and greater than 50. The sum of the squares of its digits is

Daar is slegs een priemgetal tussen 50 en 90 waarvan die omgekeerde (die getal verkry deur die syfers in omgekeerde volgorde te skryf) ook 'n priemgetal is, en groter as 50 is. Die som van die kwadrate van sy syfers is

(1) 182 (2) 130 (3) 160 (4) 144 (5) 128

12. Which is the middle number of the following five?

Watter is die middelste een van die volgende vyf getalle?

(1) 9^{-3} (2) 9^3 (3) 10 (4) -1 (5) 9^{-2}

13. Anna likes to drink a mixture of fruit juice and lemonade. One day she half filled a glass with fruit juice, then filled it with lemonade. After mixing the two liquids thoroughly, she drank one-third of the amount, and then again filled the glass with lemonade. What fraction of this mixture was fruit juice?

Anna hou daarvan om 'n mengsel van vrugtesap en limonade te drink. Eendag het sy 'n glas halfpad gevul met vrugtesap, en dit daarna volgemaak met limonade. Nadat sy die twee vloeistowwe deeglik gemeng het, het sy een-derde van die inhoud gedrink en daarna die glas weer volgemaak met limonade. Watter breuk van hierdie mengsel was toe vrugtesap?

(1) $\frac{1}{6}$ (2) $\frac{1}{3}$ (3) $\frac{1}{2}$ (4) $\frac{3}{4}$ (5) $\frac{5}{6}$

14. Two dice are rolled. What is the probability that the sum of the numbers shown is odd?

Twee dobbelstene word gegooi. Wat is die waarskynlikheid dat die som van die getalle getoon onewe is?

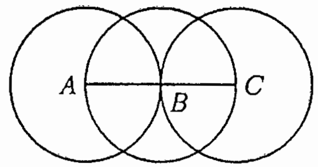
(1) $\frac{1}{6}$ (2) $\frac{1}{9}$ (3) $\frac{1}{4}$ (4) $\frac{2}{3}$ (5) $\frac{1}{2}$

15. A cube of side 4 cm is made up of 64 small 1 cm cubes. How many of these 1 cm cubes are face-to-face with exactly four other 1 cm cubes?

'n Kubus met 'n sykant van 4 cm is opgebou uit 64 klein 1 cm-kubussies. Hoeveel van hierdie 1 cm-kubussies raak gesig-aan-gesig met presies 4 ander 1 cm-kubussies?

(1) 6 (2) 8 (3) 16 (4) 24 (5) 28

16. In the diagram, A, B and C are the centres of the three circles, each of radius r.



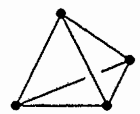
A beetle starts at A and has to walk along every line in the diagram at least once. What is the shortest distance it has to travel?

In die figuur is A, B en C die middelpunte van die drie sirkels, elk met radius r.

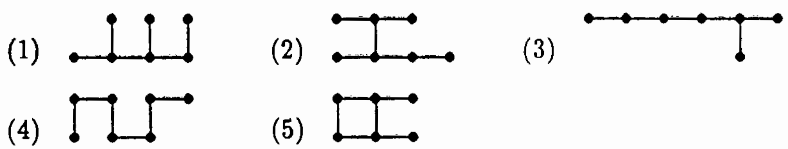
'n Gogga begin by A. Dit moet ten minste een keer langs elke lyn in die diagram loop. Wat is die kortste afstand wat dit moet loop?

(1) $2\pi r^2 + 2r$ (2) $6\pi r + 2r$ (3) $4\pi r$ (4) $6\pi r$ (5) $14r^2$

17. Six rods of equal length are joined together loosely at their ends, in five different ways, as shown below. Which of the linkages *cannot* be formed into a tetrahedron by joining rods together at their ends?

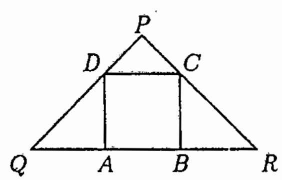


Ses stokkies van gelyke lengte word losweg aan mekaar gekoppel by hul ente, op vyf verskillende maniere, soos hieronder getoon. Watter een van die koppelings ***kan nie*** omvorm word in 'n viervlak (tetraëder) deur stokkies by hul ente aan mekaar te koppel nie ?



18. A square $ABCD$ is inscribed in an isosceles right-angled triangle PQR with right angle at P. What is the ratio

$$\frac{\text{area } ABCD}{\text{area } PQR}?$$

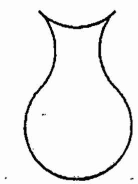


'n Vierkant $ABCD$ is ingeskrewe in 'n gelykbenige reghoekige driehoek PQR met die regte hoek by P. Wat is die verhouding

$$\frac{\text{oppervlakte } ABCD}{\text{oppervlakte } PQR}?$$

(1) $\frac{1}{2}$ (2) $\frac{3}{8}$ (3) $\frac{4}{9}$ (4) $\frac{5}{8}$ (5) $\frac{5}{9}$

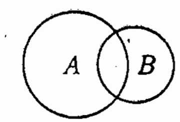
19. The shape shown is made from three quarter circles and one three-quarter circle, all of radius r. What is the area of the figure?



Die figuur getoon is gemaak van drie kwartsirkels en een driekwartsirkel, elk met 'n radius r. Wat is die oppervlakte van die figuur?

(1) $4r^2$ (2) $(\pi + 1)r^2$ (3) $\frac{3\pi r^2}{2}$ (4) $\sqrt{2}\pi r^2$ (5) $2\pi r^2$

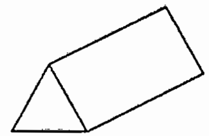
20. Two circles of radii 7 cm and 5 cm intersect, with their centres 8 cm apart. What is the difference in area between the shaded region **A** and the shaded region **B**?

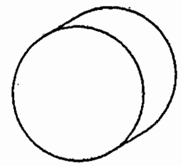


Twee sirkels met radii 7 cm en 5 cm sny, met hul middelpunte 8 cm van mekaar af. Wat is die verskil in oppervlakte tussen die verdonkerde deel **A** en die verdonkerde deel **B**?

(1) 12π cm^2 (2) 24π cm^2 (3) 35π cm^2 (4) $\sqrt{74}\pi$ cm^2
(5) $\sqrt{99}\pi$ cm^2

21. Chocolate comes in two containers: a triangular prism and a cylinder. The cylinder has diameter $2\sqrt{3}$. The end of the prism is an equilateral triangle with height $\sqrt{3}$. If the prism is three times as long as the cylinder, the ratio of the volume of the prism to the volume of the cylinder is





Sjokolade word in twee houers verpak: 'n driehoekige prisma en 'n silinder. Die silinder se middellyn is $2\sqrt{3}$. Die basis van die prisma is 'n gelyksydige driehoek met hoogte $\sqrt{3}$. As die prisma drie keer so lank as die silinder is, is die verhouding van die volume van die prisma tot die volume van die silinder

(1) $2:3\pi$ (2) $3:2\pi$ (3) $\sqrt{3}:\pi$ (4) $\sqrt{3}:2\pi$ (5) $2\sqrt{3}:\pi$

22. If $\dfrac{x}{8-y} = \dfrac{y}{15-z} = \dfrac{z}{10-x} = 2$, the value of $x+y+z$ is

As $\dfrac{x}{8-y} = \dfrac{y}{15-z} = \dfrac{z}{10-x} = 2$, dan is die waarde van $x+y+z$

(1) 22 (2) 31 (3) 44 (4) 53 (5) 67

23. If $15 \leqslant x \leqslant 25$ and $y - x = 3$, then the greatest value of $x + y$ is

As $15 \leqslant x \leqslant 25$ en $y - x = 3$, dan is die grootste waarde van $x + y$

(1) 28 (2) 40 (3) 43 (4) 50 (5) 53

24. A jogger ran for 90 mins. She first ran along a level track and then up a hill to the top, where she turned around and ran back to her starting point along the same route. She ran at 8 km/h along the level track, 6 km/h uphill and 12 km/h downhill. The total distance she ran was, in kilometres

'n Drawwer draf 90 min. lank. Eers hardloop sy op 'n gelykte en daarna teen 'n heuwel op tot bo. Hier draai sy om en hardloop met dieselfde roete terug na haar beginpunt. Sy het teen 8 km/h op die gelykte gehardloop, teen 6 km/h heuwel op en teen 12 km/h heuwel af. Die totale afstand wat sy (in kilometers) gedraf het, was

(1) 8 (2) 13 (3) 15 (4) 12
(5) Not enough information/Nie genoeg inligting nie

25. John had three $3 \times 3 \times 3$ wooden cubes. He painted one side of one cube, two sides of the second cube and three sides of the third cube: all red. He then cut each cube into 27 small $1 \times 1 \times 1$ cubes, and counted the small cubes which had no painted sides.

Which of the following totals could he *not* have obtained?

Jan het drie $3 \times 3 \times 3$ hout-kubusse. Hy verf een sykant van een kubus, twee sykante van die tweede kubus en drie sykante van die derde kubus: almal rooi. Hierna sny hy elke kubus in 27 klein $1 \times 1 \times 1$ kubussies. Hy tel die aantal klein kubussies met geen geverfde kante nie.

Watter een van die volgende totale sou hy *nie* kon kry nie?

(1) 33 (2) 34 (3) 35 (4) 36 (5) 38

26. Let r be a root of $x^2 + 5x + 3 = 0$. The value of $(r-1)(r+2)(r+3)(r+6)$ is

Laat r 'n wortel wees van $x^2 + 5x + 3 = 0$. Dan is die waarde van $(r-1)(r+2)(r+3)(r+6)$

(1) -27 (2) $5\sqrt{13}$ (3) 24 (4) $\frac{1}{2}(33 \pm \sqrt{13})$ (5) $\frac{1}{4}(25 \pm 5\sqrt{13})$

27. The unit digit of $3^{1997} + 4^{1997} + 5^{1997} + 6^{1997}$ is

Die ene syfer van $3^{1997} + 4^{1997} + 5^{1997} + 6^{1997}$ is

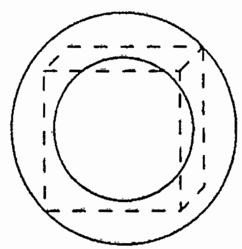
(1) 0 (2) 2 (3) 6 (4) 4 (5) 8

28. Bud the Spud had a summer job on a farm. He had four bags of potatoes to weigh but each bag weighed less than 100 kg and the scale only weighed in excess of 100 kg. He solved the problem by weighing the bags two at a time. He found the weighings to be 103, 105, 106, 106, 107 and 109 kilograms. The weight of the lightest bag, in kilograms, was

Piet Patat het vakansiewerk op 'n plaas gedoen. Hy moes vier sakke aartappels weeg, maar elke sak het minder as 100 kg geweeg, terwyl die skaal slegs gewigte van meer as 100 kg kon weeg. Hy het die probleem opgelos deur die sakke twee op 'n slag te weeg. Die gewigte was 103, 105, 106, 106, 107 en 109 kilogram. Die gewig van die ligste sak, in kilogram, was

(1) 50 (2) 51 (3) 49 (4) 52 (5) 48

29. In the diagram, there is a masterpiece of the glass-blower's art: a perfect glass sphere. Inside it is a cube whose vertices just touch the containing sphere and, inside the cube in turn, is a smaller sphere which just touches the six faces of the cube. What is the ratio of the volume of the smaller sphere to that of the larger one?



In die figuur is daar 'n meesterstuk van die glasblaserkuns: 'n perfekte glas-sfeer. Binne-in is 'n kubus waarvan die hoekpunte net raak aan die sfeer waarin dit bevat is. Binne-in die kubus weer is 'n nog kleiner sfeer wat net raak aan die ses sykante van die kubus. Wat is die verhouding van die volume van die klein sfeer tot die volume van die groot een?

(1) $1 : 2\sqrt{2}$ (2) $1 : 3\sqrt{3}$ (3) $1 : 2$ (4) $1 : 3$ (5) $1 : \pi$

30. The largest integer n such that $n\sqrt{13} < (n+1)\sqrt{11}$ is

Die grootste heelgetal n sodanig dat $n\sqrt{13} < (n+1)\sqrt{11}$, is

(1) 12 (2) 11 (3) 10 (4) 13 (5) 14

Standard 8

Question		1	2	3	4	5	Abstain
1	Individual	1	1	4	6	[88]	1
	Pairs	1	1	2	5	[90]	1
2	Individual	3	2	3	[86]	2	5
	Pairs	3	1	1	[91]	1	3
3	Individual	2	1	[92]	5	0	0
	Pairs	0	1	[95]	3	0	1
4	Individual	3	[62]	6	4	2	23
	Pairs	3	[66]	7	4	1	19
5	Individual	49	3	[30]	8	4	7
	Pairs	56	2	[28]	9	2	3
6	Individual	3	2	10	[38]	22	25
	Pairs	1	2	9	[32]	36	19
7	Individual	5	45	[29]	3	4	14
	Pairs	5	59	[21]	2	3	9
8	Individual	[42]	9	8	8	5	29
	Pairs	[45]	5	5	15	5	24
9	Individual	12	[58]	2	3	2	23
	Pairs	17	[54]	2	3	1	22
10	Individual	7	27	[25]	15	8	18
	Pairs	10	30	[25]	15	5	15
11	Individual	4	[51]	4	7	5	30
	Pairs	2	[59]	7	5	3	23
12	Individual	5	2	17	42	[22]	12
	Pairs	5	1	20	44	[21]	8
13	Individual	23	[57]	6	3	5	6
	Pairs	19	[60]	5	4	7	4
14	Individual	6	4	10	11	[50]	18
	Pairs	10	5	7	12	[51]	15
15	Individual	3	18	32	[21]	4	22
	Pairs	2	20	35	[23]	5	15

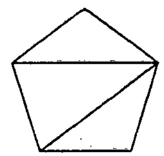
Question		1	2	3	4	5	Abstain
16	Individual	8	[42]	7	5	3	35
	Pairs	6	[45]	11	5	2	30
17	Individual	8	3	19	[16]	29	26
	Pairs	11	5	16	[11]	38	20
18	Individual	9	11	[35]	11	2	32
	Pairs	12	7	[34]	15	3	29
19	Individual	[7]	8	39	3	5	38
	Pairs	[9]	5	45	4	5	31
20	Individual	11	[16]	11	4	2	56
	Pairs	13	[20]	10	5	1	51
21	Individual	13	12	[8]	13	9	44
	Pairs	11	14	[10]	14	11	40
22	Individual	[18]	12	7	6	3	55
	Pairs	[16]	18	9	6	3	48
23	Individual	9	5	14	5	[40]	29
	Pairs	5	8	17	4	[36]	29
24	Individual	3	14	5	[10]	45	23
	Pairs	2	17	6	[9]	47	19
25	Individual	12	[13]	7	10	16	42
	Pairs	15	[11]	10	11	13	40
26	Individual	[5]	4	8	6	5	72
	Pairs	[9]	6	8	8	7	62
27	Individual	7	9	13	6	[19]	46
	Pairs	9	8	11	10	[21]	40
28	Individual	7	[31]	11	9	10	33
	Pairs	7	[38]	5	11	9	31
29	Individual	6	[9]	15	17	3	49
	Pairs	7	[9]	16	13	5	50
30	Individual	9	[10]	11	13	10	47
	Pairs	12	[9]	10	14	14	41

STANDARD 9/STANDERD 9

1. $(7a+5b)-(5a-7b)$ is equal to/is gelyk aan

(1) $12a-12b$ (2) $2a-2b$ (3) 0 (4) $2a+12b$ (5) $12a-2b$

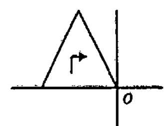
2. The diagram shows a regular pentagon with two of its diagonals. If all of its diagonals are drawn, into how many regions will the pentagon be divided?



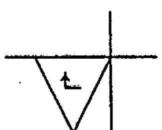
Die figuur toon 'n reëlmatige vyfhoek met twee van sy hoeklyne. As al sy hoeklyne getrek word, in hoeveel gebiede sal die vyfhoek verdeel wees?

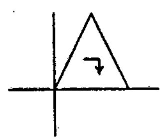
(1) 4 (2) 5 (3) 8 (4) 10 (5) 11

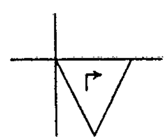
3. The triangle shown is rotated 180° about O. What is the outcome?

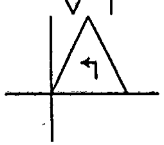


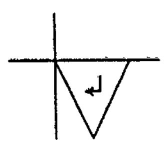
Die driehoek getoon word deur 180° gedraai om punt O. Wat is die resultaat?

(1) 

(2) 

(3) 

(4) 

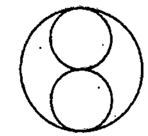
(5) 

4. Nine bus stops are equally spaced along a bus route. The distance from the first to the third is 600m. How far is it from the first to the ninth?

Nege bushaltes is gelyk gespasiëer op 'n busroete. Die afstand van die eerste tot by die derde is 600m. Hoe ver is dit van die eerste tot by die negende?

(1) 600m (2) 1600m (3) 1800m (4) 2400m (5) 2700m

5. In the diagram, the two small circles are equal and tangent to each other and tangent to the large circle. The ratio of the shaded area to the area of the large circle is



In die figuur is die twee klein sirkels gelyk, asook raaklynig aan mekaar en aan die groot sirkel. Die verhouding van die verdonkerde oppervlakte tot die oppervlakte van die groot sirkel is

(1) $1:2$ (2) $1:3$ (3) $1:4$ (4) $2:3$ (5) $2:5$

6. In triangle $ABC, \angle A \leqslant \angle B \leqslant \angle C = 85°$. The smallest possible size of $\angle A$ is

In driehoek ABC is $\angle A \leqslant \angle B \leqslant \angle C = 85°$. Die kleinste moontlike grootte van $\angle A$ is

(1) 0° (2) 1° (3) 5° (4) 10° (5) 20°

7. If $p \otimes q$ means $3p+q^2$, then $(3 \otimes 4) \otimes 5$ is equal to

As $p \otimes q$ beteken $3p+q^2$, dan is $(3 \otimes 4) \otimes 5$ gelyk aan

(1) 60 (2) 100 (3) 87 (4) 72 (5) 91

8. What is the minimum number of circular discs of the same size required to completely cover another disc of the same size so that any disc may touch, but not overlap, the centre of the covered disc when viewed from above?

Wat is die minimum aantal sirkelvormige skywe van dieselfde grootte wat benodig word om nog 'n skyf van dieselfde grootte heeltemal te bedek, op so 'n manier dat enige skyf (soos van bo af gesien) aan die middelpunt van die bedekte skyf mag raak, maar dit nie mag oordek nie?

(1) 6 (2) 4 (3) 3 (4) 2 (5) 5

9. The square root of 16129 is

Die vierkantswortel van 16129 is

(1) 123 (2) 133 (3) 137 (4) 117 (5) 127

10. At which one of these times is the angle between the two hands of a clock exactly 170°

Op watter een van die volgende tye is die hoek tussen die twee wysters van 'n horlosie presies 170°

(1) 10:20 (2) 1:35 (3) 9:15 (4) 12:30 (5) 11:25

11. There is only one prime number between 50 and 90 whose reversal (the number obtained by writing its digits in reverse order) is also a prime number, and greater than 50. The sum of the squares of its digits is

Daar is slegs een priemgetal tussen 50 en 90 waarvan die omgekeerde (die getal verkry deur die syfers in omgekeerde volgorde te skryf) ook 'n priemgetal is, en groter as 50 is. Die som van die kwadrate van sy syfers is

(1) 182 (2) 130 (3) 160 (4) 144 (5) 128

Standard 9/Standerd 9

12. The mathematicians of ancient Egypt used the following method for calculating the area of a circle:

"Take one-ninth of the diameter away from the diameter and square the result."

What approximate value of π gives the same answer as the Egyptian method?

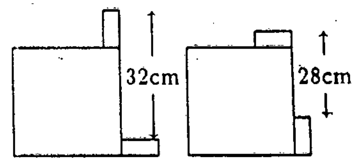
Die wiskundiges van antieke Egipte het die volgende metode gebruik om die oppervlakte van 'n sirkel te bereken:

"Trek een-negende van die middellyn af van die middellyn en kwadreer die resultaat."

Watter benaderde waarde van π gee dieselfde antwoord as die Egiptiese metode?

(1) $3\frac{1}{7}$ (2) $3\frac{1}{9}$ (3) $3\frac{3}{32}$ (4) $3\frac{13}{81}$ (5) $3\frac{16}{113}$

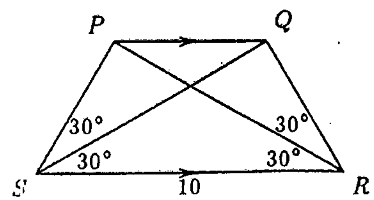
13. A large box and two identical small bricks are arranged in two ways, as shown. How high is the box?



'n Groot karton en twee eenderse klein bakstene word op twee maniere gerangskik, soos getoon. Hoe hoog is die karton?

(1) 28 cm (2) 29 cm (3) 30 cm (4) 31 cm (5) 32 cm

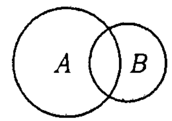
14. The diagonals of a trapezium $PQRS$ make angles of 30° as shown. The base RS has length 10. What is the perimeter of the trapezium?



Die hoeklyne van 'n trapesium $PQRS$ maak hoeke van $30°$ soos getoon. Die basis RS se lengte is 10. Wat is die omtrek van die trapesium?

(1) 15 (2) $10\sqrt{3}$ (3) 25 (4) $15\sqrt{3}$ (5) 30

15. Two circles of radii 7 cm and 5 cm intersect, with their centres 8 cm apart. What is the difference in area between the shaded region **A** and the shaded region **B**?



Twee sirkels met radii 7 cm en 5 cm sny, met hul middelpunte 8 cm van mekaar af. Wat is die verskil in oppervlakte tussen die verdonkerde deel **A** en die verdonkerde deel **B**?

(1) 12π cm^2 (2) 24π cm^2 (3) 35π cm^2 (4) $\sqrt{74}\pi$ cm^2
(5) $\sqrt{99}\pi$ cm^2

16. Point X is chosen on the side CD of the parallelogram $ABCD$ in such a way that $XC = CB$, $XB = AB$ and $XA = AD$. Then $\angle ADX$ is equal to

Punt X word gekies op sy CD van parallelogram $ABCD$ op so 'n manier dat $XC = CB$, $XB = AB$ en $XA = AD$. Dan is $\angle ADX$ gelyk aan

(1) $30°$ (2) $45°$ (3) $60°$ (4) $72°$ (5) $90°$

17. Which one of the following statements is false?

Watter een van die volgende stellings is verkeerd?

(1) $(-1)^{2n} = 1$ for every integer n / vir elke heelgetal n
(2) $(-1)^{n-1} = (-1)^{n+1}$ for every positive integer n /vir elke positiewe heelgetal n
(3) $(-1)^{n^2} = (-1)^n$ for every negative integer n /vir elke negatiewe heelgetal n
(4) $(-1)^{3n} = (-1)^{2n}$ for every odd integer n /vir elke onewe heelgetal n
(5) $(-1)^{2n-1} = -(-1)^n$ for every even integer n /vir elke ewe heelgetal n

Standard 9/Standerd 9

18. If $\dfrac{x}{8-y} = \dfrac{y}{15-z} = \dfrac{z}{10-x} = 2$, the value of $x+y+z$ is

As $\dfrac{x}{8-y} = \dfrac{y}{15-z} = \dfrac{z}{10-x} = 2$, dan is die waarde van $x+y+z$

(1) 22 (2) 31 (3) 44 (4) 53 (5) 67

19. If $15 \leqslant x \leqslant 25$ and $y - x = 3$, then the greatest value of $x + y$ is

As $15 \leqslant x \leqslant 25$ en $y - x = 3$, dan is die grootste waarde van $x + y$

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20. A jogger ran for 90 mins. She first ran along a level track and then up a hill to the top, where she turned around and ran back to her starting point along the same route. She ran at 8 km/h along the level track, 6 km/h uphill and 12 km/h downhill. The total distance she ran was, in kilometres

'n Drawwer draf 90 min. lank. Eers hardloop sy op 'n gelykte en daarna teen 'n heuwel op tot bo. Hier draai sy om en hardloop met dieselfde roete terug na haar beginpunt. Sy het teen 8 km/h op die gelykte gehardloop, teen 6 km/h heuwel op en teen 12 km/h heuwel af. Die totale afstand wat sy (in kilometers) gedraf het, was

(1) 8 (2) 13 (3) 15 (4) 12
(5) Not enough information/Nie genoeg inligting nie

21. John had three $3 \times 3 \times 3$ wooden cubes. He painted one side of one cube, two sides of the second cube and three sides of the third cube: all red. He then cut each cube into 27 small $1 \times 1 \times 1$ cubes, and counted the small cubes which had no painted sides.

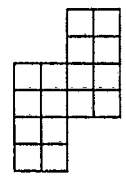
Which of the following totals could he *not* have obtained?

Jan het drie $3 \times 3 \times 3$ hout-kubusse. Hy verf een sykant van een kubus, twee sykante van die tweede kubus en drie sykante van die derde kubus: almal rooi. Hierna sny hy elke kubus in 27 klein $1 \times 1 \times 1$ kubussies. Hy tel die aantal klein kubussies met geen geverfde kante nie.

Watter een van die volgende totale sou hy *nie* kon kry nie?

(1) 33 (2) 34 (3) 35 (4) 36 (5) 38

22. From a sheet of sixteen stamps as shown, the number of ways of choosing 3 connected stamps is



Uit 'n vel van sestien seëls soos getoon, is die aantal maniere om 3 seëls wat aan mekaar vas is te kies

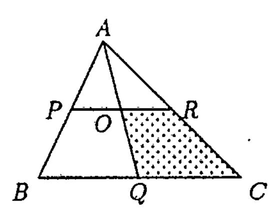
(1) 41 (2) 40 (3) 42 (4) 35 (5) 44

23. Let r be a root of $x^2 + 5x + 3 = 0$. The value of $(r-1)(r+2)(r+3)(r+6)$ is

Laat r 'n wortel wees van $x^2 + 5x + 3 = 0$. Dan is die waarde van $(r-1)(r+2)(r+3)(r+6)$

(1) -27 (2) $5\sqrt{13}$ (3) 24 (4) $\frac{1}{2}(33 \pm \sqrt{13})$ (5) $\frac{1}{4}(25 \pm 5\sqrt{13})$

24. In the figure, P, Q and R are the midpoints of the sides AB, BC and CA respectively of triangle ABC, and AQ and PR intersect in O. The ratio $\frac{\text{area } ORCQ}{\text{area } ABC}$ is equal to



In die diagram is P, Q en R die middelpunte van onderskeidelik AB, BC en CA, die sye van die driehoek ABC, en sny AQ en PR mekaar in O. Die breuk $\frac{\text{oppervlakte } ORCQ}{\text{oppervlakte } ABC}$ is gelyk aan

(1) $\frac{3}{8}$ (2) $\frac{1}{3}$ (3) $\frac{7}{16}$ (4) $\frac{2}{5}$ (5) $\frac{5}{16}$

25. The unit digit of $3^{1997} + 4^{1997} + 5^{1997} + 6^{1997}$ is

Die ene syfer van $3^{1997} + 4^{1997} + 5^{1997} + 6^{1997}$ is

(1) 0 (2) 2 (3) 6 (4) 4 (5) 8

26. Bud the Spud had a summer job on a farm. He had four bags of potatoes to weigh but each bag weighed less than 100 kg and the scale only weighed in excess of 100 kg. He solved the problem by weighing the bags two at a time. He found the weighings to be 103, 105, 106, 106, 107 and 109 kilograms. The weight of the lightest bag, in kilograms, was

Piet Patat het vakansiewerk op 'n plaas gedoen. Hy moes vier sakke aartappels weeg, maar elke sak het minder as 100 kg geweeg, terwyl die skaal slegs gewigte van meer as 100 kg kon weeg. Hy het die probleem opgelos deur die sakke twee op 'n slag te weeg. Die gewigte was 103, 105, 106, 106, 107 en 109 kilogram. Die gewig van die ligste sak, in kilogram, was

(1) 50 (2) 51 (3) 49 (4) 52 (5) 48

27. An equilateral triangle and a regular hexagon have equal perimeters. What is the ratio

area of triangle : area of hexagon?

'n Gelyksydige driehoek en 'n reëlmatige seshoek het gelyke omtrekke. Wat is die verhouding

oppervlakte van driehoek : oppervlakte van seshoek?

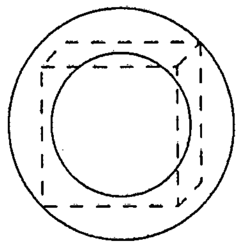
(1) 1 : 2 (2) 2 : 3 (3) 1 : 1 (4) 3 : 4 (5) 1 : 3

28. If $x = \dfrac{1+\sqrt{5}}{2}$ then $(x^3 - 2x - 3)^3$ is equal to

As $x = \dfrac{1+\sqrt{5}}{2}$ dan is $(x^3 - 2x - 3)^3$ gelyk aan

(1) -8 (2) 0 (3) $\dfrac{3-17\sqrt{5}}{4}$ (4) $\dfrac{-6-12\sqrt{5}}{4}$ (5) 1

29. In the diagram, there is a masterpiece of the glass-blower's art: a perfect glass sphere. Inside it is a cube whose vertices just touch the containing sphere and, inside the cube in turn, is a smaller sphere which just touches the six faces of the cube. What is the ratio of the volume of the smaller sphere to that of the larger one?



In die figuur is daar 'n meesterstuk van die glasblaserkuns: 'n perfekte glas-sfeer. Binne-in is 'n kubus waarvan die hoekpunte net raak aan die sfeer waarin dit bevat is. Binne-in die kubus weer is 'n nog kleiner sfeer wat net raak aan die ses sykante van die kubus. Wat is die verhouding van die volume van die klein sfeer tot die volume van die groot een?

(1) $1:2\sqrt{2}$ (2) $1:3\sqrt{3}$ (3) $1:2$ (4) $1:3$ (5) $1:\pi$

30. Which one of the numbers listed below is a root of the equation $x^4 - 14x^3 + 50x^2 - 14x + 1 = 0$?

Watter een van die volgende getalle is 'n wortel van die vergelyking $x^4 - 14x^3 + 50x^2 - 14x + 1 = 0$?

(1) $4-2\sqrt{3}$ (2) $3-2\sqrt{2}$ (3) $6-2\sqrt{7}$ (4) $7-2\sqrt{5}$ (5) $5-2\sqrt{6}$

Standard 9

Question		1	2	3	4	5	Abstain
1	Individual	2	13	2	[80]	2	2
	Pairs	0	8	1	[88]	1	1
2	Individual	3	12	14	4	[65]	3
	Pairs	0	9	6	2	[81]	2
3	Individual	4	13	5	4	[73]	3
	Pairs	3	10	4	2	[79]	3
4	Individual	0	2	29	[63]	5	0
	Pairs	0	2	28	[64]	5	0
5	Individual	[55]	5	8	7	4	20
	Pairs	[46]	3	8	10	3	29
6	Individual	5	22	12	[38]	10	13
	Pairs	2	20	8	[47]	8	15
7	Individual	11	[71]	3	3	1	11
	Pairs	13	[65]	1	4	0	17
8	Individual	10	28	[27]	12	6	17
	Pairs	10	30	[21]	9	7	22
9	Individual	12	6	3	2	[69]	8
	Pairs	7	1	2	2	[83]	5
10	Individual	[36]	19	8	7	14	16
	Pairs	[25]	24	10	6	18	17
11	Individual	5	[55]	5	7	5	22
	Pairs	2	[63]	3	5	3	23
12	Individual	26	10	5	[23]	3	33
	Pairs	32	8	4	[17]	3	36
13	Individual	11	7	[56]	5	6	15
	Pairs	10	8	[57]	3	4	18
14	Individual	3	10	[23]	12	15	37
	Pairs	2	5	[28]	10	14	41
15	Individual	13	[23]	14	7	2	41
	Pairs	13	[18]	10	4	1	54

Question		1	2	3	4	5	Abstain
16	Individual	10	15	19	[14]	14	28
	Pairs	6	14	22	[13]	12	32
17	Individual	11	9	11	[36]	14	20
	Pairs	6	11	13	[28]	8	35
18	Individual	[24]	8	7	8	5	46
	Pairs	[20]	8	6	5	5	56
19	Individual	8	4	12	2	[58]	16
	Pairs	6	4	14	3	[47]	27
20	Individual	4	12	5	[12]	43	24
	Pairs	3	10	6	[12]	40	29
21	Individual	14	[13]	9	9	19	36
	Pairs	12	[11]	9	9	15	43
22	Individual	5	20	[20]	17	15	23
	Pairs	4	21	[20]	20	10	26
23	Individual	[7]	5	10	12	8	58
	Pairs	[5]	6	8	7	7	67
24	Individual	[14]	32	5	10	7	32
	Pairs	[10]	29	5	9	7	40
25	Individual	11	9	14	7	[23]	37
	Pairs	5	9	11	5	[19]	50
26	Individual	8	[27]	10	9	13	33
	Pairs	7	[23]	10	7	10	41
27	Individual	17	[17]	13	9	13	31
	Pairs	17	[15]	18	7	13	30
28	Individual	[7]	6	12	10	11	53
	Pairs	[8]	5	8	9	5	64
29	Individual	6	[11]	13	13	9	48
	Pairs	7	[4]	8	12	9	60
30	Individual	6	[7]	11	12	5	58
	Pairs	3	[7]	9	9	4	68

STANDARD 10/STANDERD 10

1. $(7a+5b)-(5a-7b)$ is equal to/is gelyk aan

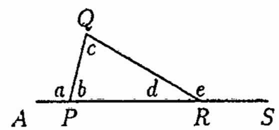
(1) $12a-12b$ (2) $2a-2b$ (3) 0 (4) $2a+12b$ (5) $12a-2b$

2. What is 72% of 75?

Wat is 72% van 75?

(1) 18 (2) 36 (3) 48 (4) 54 (5) 96

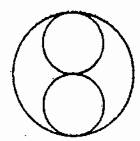
3. In the diagram, $PR = QR$. The value of a is



In die figuur is $PR = QR$. Die waarde van a is

(1) $b+e$ (2) $c+e$ (3) $180^\circ - d$ (4) $180^\circ - e + b$
(5) $180^\circ - c + d$

4. In the diagram, the two small circles are equal and tangent to each other and tangent to the large circle. The ratio of the shaded area to the area of the large circle is



In die figuur is die twee klein sirkels gelyk, asook raaklynig aan mekaar en aan die groot sirkel. Die verhouding van die verdonkerde oppervlakte tot die oppervlakte van die groot sirkel is

(1) 1 : 2 (2) 1 : 3 (3) 1 : 4 (4) 2 : 3 (5) 2 : 5

5. If $p \otimes q$ means $3p+q^2$, then $(3 \otimes 4) \otimes 5$ is equal to

As $p \otimes q$ beteken $3p+q^2$, dan is $(3 \otimes 4) \otimes 5$ gelyk aan

(1) 60 (2) 100 (3) 87 (4) 72 (5) 91

6. There is only one prime number between 50 and 90 whose reversal (the number obtained by writing its digits in reverse order) is also a prime number, and greater than 50. The sum of the squares of its digits is

Daar is slegs een priemgetal tussen 50 en 90 waarvan die omgekeerde (die getal verkry deur die syfers in omgekeerde volgorde te skryf) ook 'n priemgetal is, en groter as 50 is. Die som van die kwadrate van sy syfers is

(1) 182 (2) 130 (3) 160 (4) 144 (5) 128

7. Which is the middle number of the following five?

Watter is die middelste een van die volgende vyf getalle?

(1) 9^{-3} (2) 9^3 (3) 10 (4) -1 (5) 9^{-2}

8. Anna likes to drink a mixture of fruit juice and lemonade. One day she half filled a glass with fruit juice, then filled it with lemonade. After mixing the two liquids thoroughly, she drank one-third of the amount, and then again filled the glass with lemonade. What fraction of this mixture was fruit juice?

Anna hou daarvan om 'n mengsel van vrugtesap en limonade te drink. Eendag het sy 'n glas halfpad gevul met vrugtesap, en dit daarna volgemaak met limonade. Nadat sy die twee vloeistowwe deeglik gemeng het, het sy een-derde van die inhoud gedrink en daarna die glas weer volgemaak met limonade. Watter breuk van hierdie mengsel was toe vrugtesap?

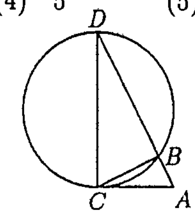
(1) $\frac{1}{6}$ (2) $\frac{1}{3}$ (3) $\frac{1}{2}$ (4) $\frac{3}{4}$ (5) $\frac{5}{6}$

9. The remainder when m is divided by 11 is 7 and the remainder when n is divided by 11 is 5. What is the remainder when mn is divided by 11?

As m deur 11 gedeel word, is die res 7. As n deur 11 gedeel word, is die res 5. Wat is die res as mn deur 11 gedeel word?

(1) 9 (2) 8 (3) 6 (4) 5 (5) 2

10. In the diagram, AC is a tangent to the circle at C, CD is a diameter of the circle and AD intersects the circle at B. If the radius of the circle is 40 mm and $CA = 60$ mm, then the length of CB is



In die figuur is AC 'n raaklyn aan die sirkel by C, CD is 'n middellyn van die sirkel en AD sny die sirkel by B. As die radius van die sirkel 40mm is en $CA = 60$ mm, dan is die lengte van CB

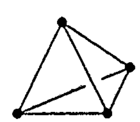
(1) 48 mm (2) 50 mm (3) 54 mm (4) 50 mm (5) 60 mm

11. If $(\sqrt{5}+\sqrt{6})^2 = \sqrt{m}+\sqrt{n}$, where m and n are positive integers, then $m+n$ is equal to

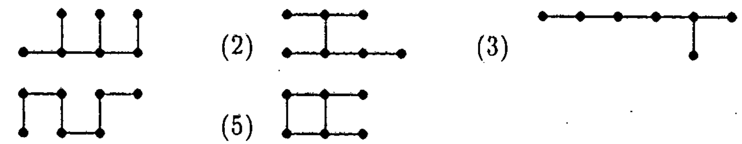
As $(\sqrt{5}+\sqrt{6})^2 = \sqrt{m}+\sqrt{n}$, waar m en n positiewe heelgetalle is, dan is $m+n$ gelyk aan

(1) 11 (2) 121 (3) 71 (4) 131 (5) 241

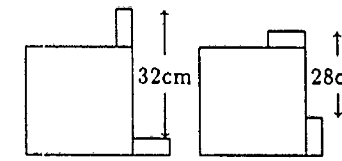
12. Six rods of equal length are joined together loosely at their ends, in five different ways, as shown below. Which of the linkages *cannot* be formed into a tetrahedron by joining rods together at their ends?



Ses stokkies van gelyke lengte word losweg aan mekaar gekoppel by hul ente, op vyf verskillende maniere, soos hieronder getoon. Watter een van die koppelings *kan nie* omvorm word in 'n viervlak (tetraëder) deur stokkies by hul ente aan mekaar te koppel nie ?



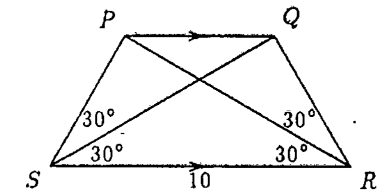
13. A large box and two identical small bricks are arranged in two ways, as shown. How high is the box?



'n Groot karton en twee eenderse klein bakstene word op twee maniere gerangskik, soos getoon. Hoe hoog is die karton?

(1) 28 cm (2) 29 cm (3) 30 cm (4) 31 cm (5) 32 cm

14. The diagonals of a trapezium $PQRS$ make angles of 30° as shown. The base RS has length 10. What is the perimeter of the trapezium?



Die hoeklyne van 'n trapesium $PQRS$ maak hoeke van 30° soos getoon. Die basis RS se lengte is 10. Wat is die omtrek van die trapesium?

(1) 15 (2) $10\sqrt{3}$ (3) 25 (4) $15\sqrt{3}$ (5) 30

15. The equation $\sqrt{x-p} = x$ has two distinct real roots. The range of possible values of p is

Die vergelyking $\sqrt{x-p} = x$ het twee afsonderlike reële wortels. Die terrein van moontlike waardes vir p is

(1) $p \leqslant 0$ (2) $p < \frac{1}{4}$ (3) $0 \leqslant p < \frac{1}{4}$ (4) $p \geqslant \frac{1}{4}$ (5) $p > 1$

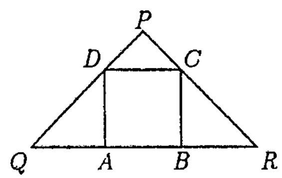
16. If $f(x) = \frac{1}{x} - 1$ and $g(x) = x - 1$ then (for $x \neq 1$) $f(g(x))$ is equal to

As $f(x) = \frac{1}{x} - 1$ en $g(x) = x - 1$, dan (as $x \neq 1$) is $f(g(x))$ gelyk aan

(1) $\frac{2-x}{x-1}$ (2) $\frac{1-x}{x}$ (3) $\frac{x}{1-x}$ (4) $\frac{1}{x+1}$ (5) x

17. A square $ABCD$ is inscribed in an isosceles right-angled triangle PQR with right angle at P. What is the ratio

$$\frac{\text{area } ABCD}{\text{area } PQR}?$$



'n Vierkant $ABCD$ is ingeskrewe in 'n gelykbenige reghoekige driehoek PQR met die regte hoek by P. Wat is die verhouding

$$\frac{\text{oppervlakte } ABCD}{\text{oppervlakte } PQR}?$$

(1) $\frac{1}{2}$ (2) $\frac{3}{8}$ (3) $\frac{4}{9}$ (4) $\frac{5}{8}$ (5) $\frac{5}{9}$

18. If $\frac{x}{8-y} = \frac{y}{15-z} = \frac{z}{10-x} = 2$, the value of $x + y + z$ is

As $\frac{x}{8-y} = \frac{y}{15-z} = \frac{z}{10-x} = 2$, dan is die waarde van $x + y + z$

(1) 22 (2) 31 (3) 44 (4) 53 (5) 67

19. If 7 white cubes and 20 red cubes, all of equal size, are glued together to form one large cube, then the smallest proportion of the surface area which could be white is

As 7 wit kubusse en 20 rooi kubusse, almal van gelyke grootte, aan mekaar vasgelym word om een groot kubus te vorm, dan is die kleinste deel van die buite-oppervlakte wat wit kan wees

(1) $\frac{1}{6}$ (2) $\frac{7}{27}$ (3) $\frac{7}{20}$ (4) $\frac{1}{9}$ (5) $\frac{7}{36}$

20. Bud the Spud had a summer job on a farm. He had four bags of potatoes to weigh but each bag weighed less than 100 kg and the scale only weighed in excess of 100 kg. He solved the problem by weighing the bags two at a time. He found the weighings to be 103, 105, 106, 106, 107 and 109 kilograms. The weight of the lightest bag, in kilograms, was

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(1) 50 (2) 51 (3) 49 (4) 52 (5) 48

21. The inequality $-8 < x < 2$ can be written

Die ongelykheid $-8 < x < 2$ kan geskryf word as

(1) $|x+6| < 2$ (2) $|x-2| < 6$ (3) $|x+3| < 5$
(4) $|x-5| < 3$ (5) $|x-6| < 2$

22. Which one of the following numbers is not a factor of $2^{24} - 1$?

Watter een van die getalle hieronder is nie 'n faktor van $2^{24} - 1$ nie?

(1) 51 (2) 61 (3) 85 (4) 91 (5) 119

23. An equilateral triangle and a regular hexagon have equal perimeters. What is the ratio

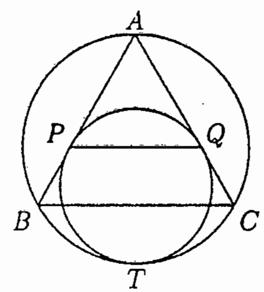
area of triangle : area of hexagon?

'n Gelyksydige driehoek en 'n reëlmatige seshoek het gelyke omtrekke. Wat is die verhouding

oppervlakte van driehoek : oppervlakte van seshoek?

(1) 1 : 2 (2) 2 : 3 (3) 1 : 1 (4) 3 : 4 (5) 1 : 3

24. Equilateral triangle ABC is inscribed in a circle. A second circle is tangent internally to the circumcircle at T and tangent to sides AB and AC at P and Q. If $BC = 12$, then PQ is equal to



Die gelyksydige driehoek ABC en sy omsirkel is gegewe. 'n Tweede sirkel het 'n interne raakpunt T met die omsirkel en raak ook die sye AB en AC onderskeidelik in P en Q. As die lengte van BC 12 is, dan is die lengte van PQ gelyk aan

(1) $5\sqrt{3}$ (2) $6\sqrt{2}$ (3) 9 (4) $7\sqrt{2}$ (5) 8

25. A student rows at a constant speed (relative to the water) downstream in the Gamka River from Komma to Kamma in 3 hours and back upstream in 4 hours. If the river flows at a constant rate, then the number of hours it would take a piece of driftwood to float downstream from Komma to Kamma is

Standard 10/Standerd 10

'n Student roei teen 'n konstante spoed (relatief tot die water) stroomaf in die Gamka Rivier vanaf Komma tot by Kamma in 3 ure en stroomop terug in 4 ure. As die rivier teen 'n konstante tempo vloei, dan is die aantal ure wat dit vir 'n stuk dryfhout sal neem om stroomaf vanaf Komma tot by Kamma te dryf

(1) 12 (2) 18 (3) 6 (4) 24 (5) 36

26. The equation $19x + 97y = 1997$ is satisfied by the positive integers $x = 100, y = 1$. There is only one other pair of positive integers satisfying the equation. Their sum is

Die vergelyking $19x + 97y = 1997$ word bevredig deur die positiewe heelgetalle $x = 100$ en $y = 1$. Daar is slegs een ander paar positiewe heelgetalle wat die vergelyking bevredig. Hul som is

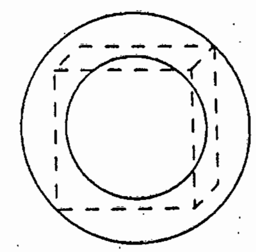
(1) 23 (2) 39 (3) 58 (4) 78 (5) 116

27. In $\Delta ABC, AB = AC$ and $\frac{\cos A}{\cos B} = \frac{7}{15}$. The value of $\frac{\sin A}{\sin B}$ is

In $\Delta ABC, AB = AC$ en $\frac{\cos A}{\cos B} = \frac{7}{15}$. Die waarde van $\frac{\sin A}{\sin B}$ is

(1) $\frac{6}{5}$ (2) $\frac{7}{6}$ (3) $\frac{15}{13}$ (4) $\frac{12}{7}$ (5) $\frac{4}{3}$

28. In the diagram, there is a masterpiece of the glass-blower's art: a perfect glass sphere. Inside it is a cube whose vertices just touch the containing sphere and, inside the cube in turn, is a smaller sphere which just touches the six faces of the cube. What is the ratio of the volume of the smaller sphere to that of the larger one?



In die figuur is daar 'n meesterstuk van die glasblaserkuns: 'n perfekte glas-sfeer. Binne-in is 'n kubus waarvan die hoekpunte net raak aan die sfeer waarin dit bevat is. Binne-in die kubus weer is 'n nog kleiner sfeer wat net raak aan die ses sykante van die kubus. Wat is die verhouding van die volume van die klein sfeer tot die volume van die groot een?

(1) $1 : 2\sqrt{2}$ (2) $1 : 3\sqrt{3}$ (3) $1 : 2$ (4) $1 : 3$ (5) $1 : \pi$

29. Which one of the numbers listed below is a root of the equation $x^4 - 14x^3 + 50x^2 - 14x + 1 = 0$?

Watter een van die volgende getalle is 'n wortel van die vergelyking $x^4 - 14x^3 + 50x^2 - 14x + 1 = 0$?

(1) $4 - 2\sqrt{3}$ (2) $3 - 2\sqrt{2}$ (3) $6 - 2\sqrt{7}$ (4) $7 - 2\sqrt{5}$ (5) $5 - 2\sqrt{6}$

30. What is the smallest integer larger than $(\sqrt{3} + \sqrt{2})^6$?

Wat is die kleinste heelgetal groter as $(\sqrt{3} + \sqrt{2})^6$?

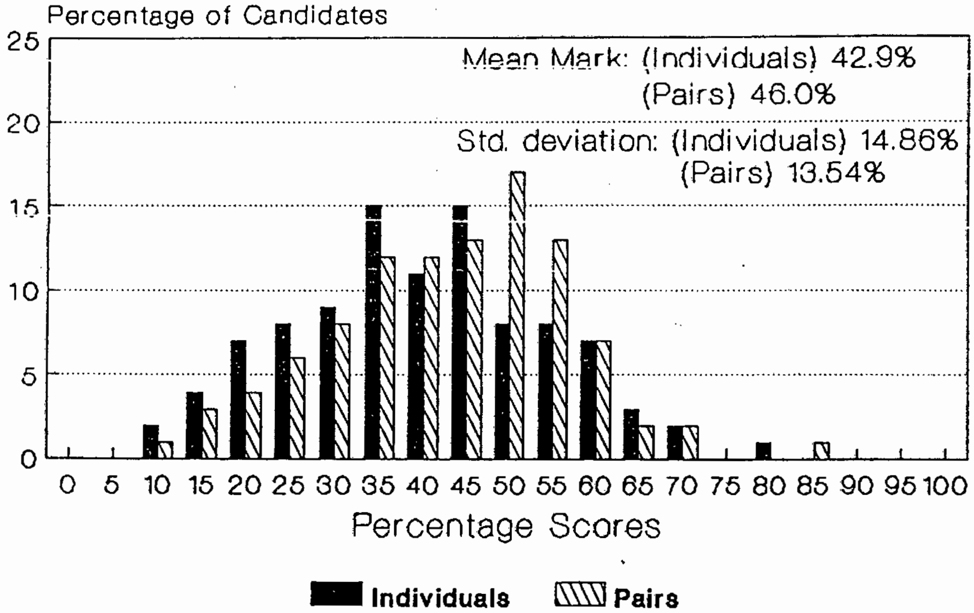
(1) 972 (2) 971 (3) 970 (4) 969 (5) 968

Standard 10

Question		1	2	3	4	5	Abstain
1	Individual	1	8	3	[87]	0	1
	Pairs	1	6	1	[89]	1	3
2	Individual	3	1	5	[85]	2	3
	Pairs	1	0	3	[92]	1	2
3	Individual	3	4	9	[50]	19	15
	Pairs	1	3	7	[49]	20	21
4	Individual	[57]	7	6	9	4	18
	Pairs	[49]	5	8	9	2	27
5	Individual	9	[75]	2	2	2	10
	Pairs	6	[72]	2	1	1	18
6	Individual	3	[55]	4	7	8	22
	Pairs	1	[66]	2	3	5	22
7	Individual	6	1	8	26	[53]	5
	Pairs	4	0	10	22	[58]	6
8	Individual	20	[61]	6	4	5	4
	Pairs	15	[68]	5	3	5	4
9	Individual	3	7	9	2	[54]	24
	Pairs	4	8	7	3	[44]	34
10	Individual	[28]	8	12	3	9	41
	Pairs	[27]	4	15	5	10	39
11	Individual	21	12	9	5	[19]	34
	Pairs	26	14	6	2	[16]	34
12	Individual	8	4	13	[23]	33	20
	Pairs	8	5	12	[19]	33	22
13	Individual	9	7	[61]	3	4	16
	Pairs	8	6	[64]	2	4	16
14	Individual	1	7	[30]	10	12	40
	Pairs	2	7	[36]	9	10	35
15	Individual	25	18	[12]	7	9	29
	Pairs	20	18	[13]	12	7	31

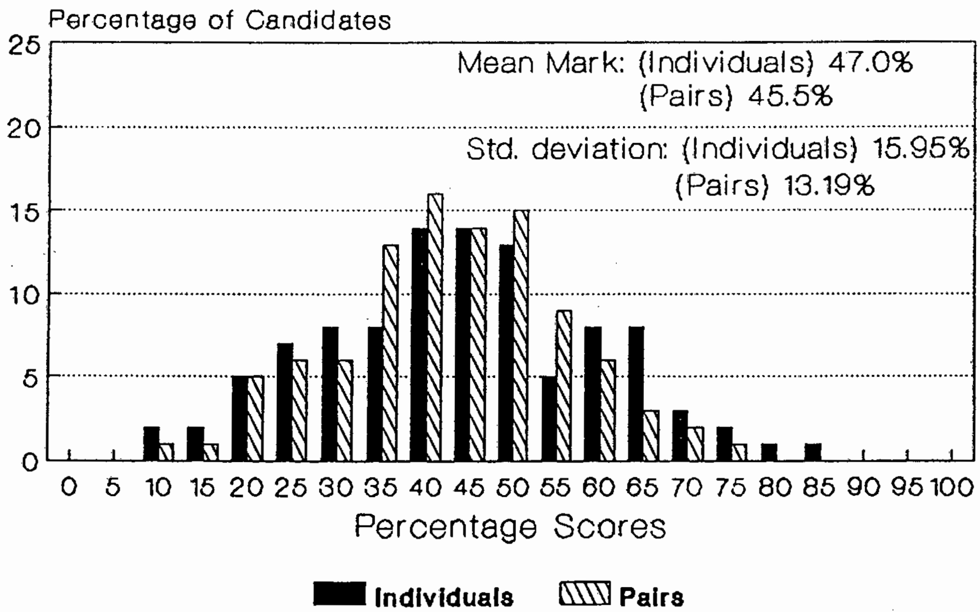
Question		1	2	3	4	5	Abstain
16	Individual	[45]	13	11	4	5	22
	Pairs	[39]	13	12	3	6	26
17	Individual	11	8	[44]	9	2	27
	Pairs	9	8	[40]	10	3	28
18	Individual	[24]	10	3	5	4	48
	Pairs	[21]	11	3	4	5	52
19	Individual	8	16	17	[28]	6	25
	Pairs	10	15	17	[21]	5	32
20	Individual	3	[29]	8	10	10	40
	Pairs	4	[27]	9	7	9	44
21	Individual	7	7	[37]	5	13	30
	Pairs	7	7	[35]	6	11	34
22	Individual	7	[7]	18	7	12	49
	Pairs	8	[8]	13	6	11	54
23	Individual	12	[21]	16	10	12	29
	Pairs	16	[16]	18	6	11	33
24	Individual	4	8	14	4	[16]	54
	Pairs	5	13	11	6	[11]	55
25	Individual	18	6	22	[9]	1	44
	Pairs	17	7	22	[6]	3	45
26	Individual	[9]	9	6	8	9	59
	Pairs	[9]	7	6	12	7	58
27	Individual	[2]	7	13	13	5	60
	Pairs	[4]	7	10	11	7	61
28	Individual	8	[10]	10	10	10	52
	Pairs	6	[12]	7	8	7	61
29	Individual	6	[7]	4	9	3	70
	Pairs	7	[6]	7	7	3	69
30	Individual	5	10	[10]	8	13	54
	Pairs	4	7	[9]	10	13	57

Standard 6



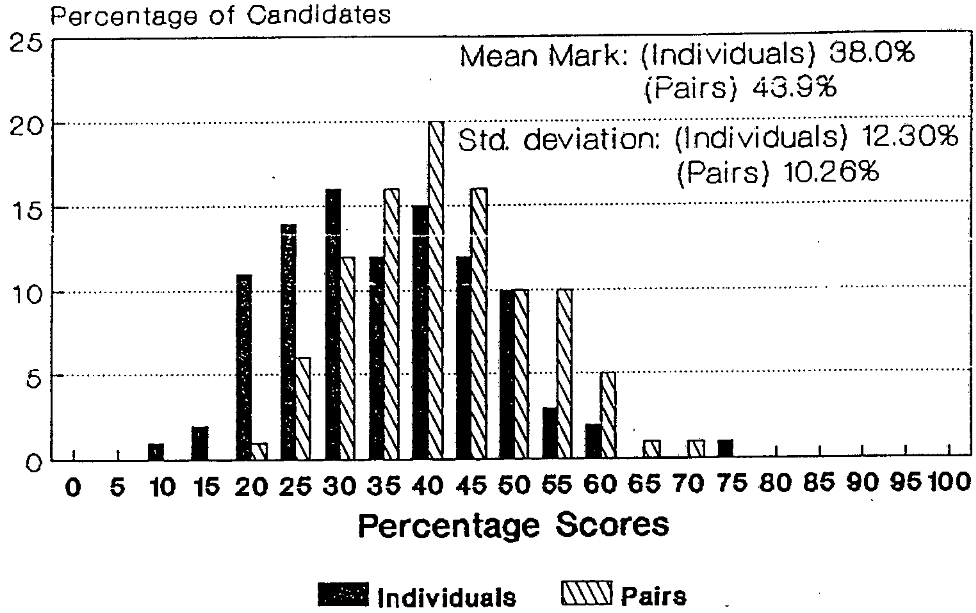
Individuals 303 Pairs 254

Standard 7



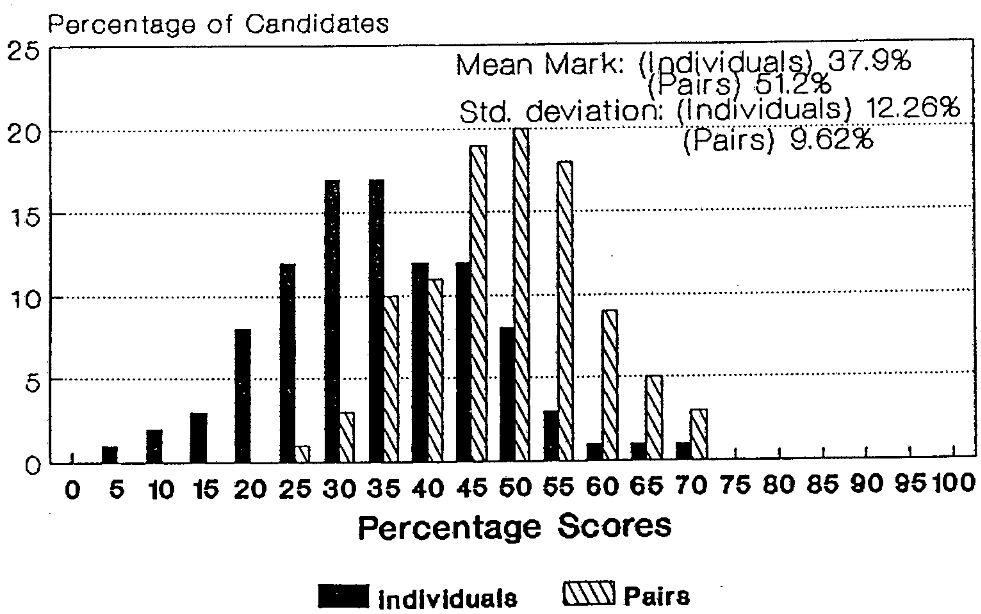
Individuals 316 Pairs 281

Standard 8

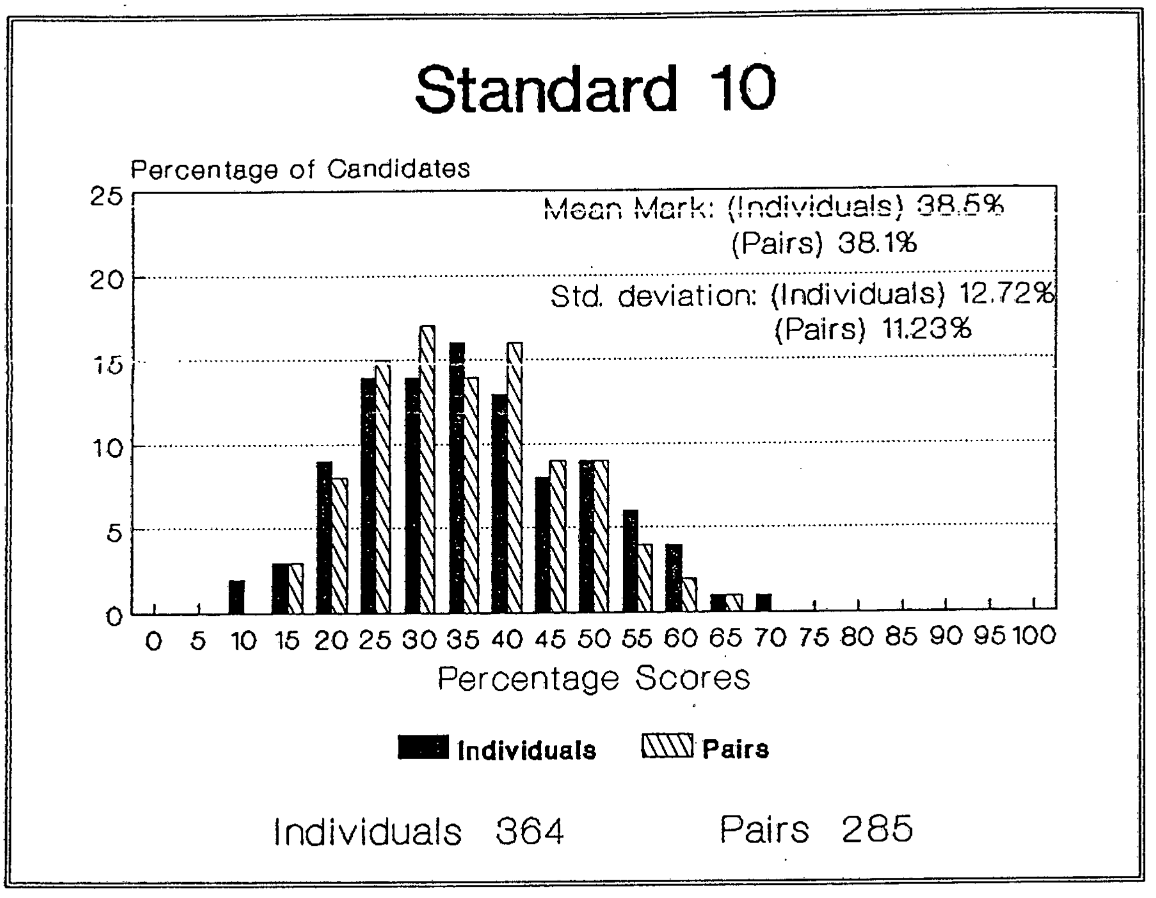


Individuals 346 Pairs 298

Standard 9



Individuals 347 Pairs 307



Standard 10
Percentage of Candidates
Mean Mark: (Individuals) 38.5%
(Pairs) 38.1%
Std. deviation: (Individuals) 12.72%
(Pairs) 11.23%
25
20
15
10
5
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Percentage Scores
Individuals
Pairs
Individuals 364
Pairs 285

ADDENDUM B

The Attitudes Questionnaire

QUESTIONNAIRE/VRAELYS

Please circle the number corresponding to your opinion about each of the following questions:
Sirkel asseblief die nommer wat ooreenstem met u mening oor elk van die volgende vrae:

Key:	1 = strongly agree	2 = agree	3 = no opinion	4 = disagree	5 = strongly disagree
Sleutel:	*1 = stem bepaald saam*	*2 = stem saam*	*3 = geen mening*	*4 = stem nie saam nie*	*5 = stem glad nie saam nie*

1	I don't usually feel nervous during a maths class *Ek voel gewoonlik nie senuweeagtig tydens 'n wiskundeklas nie*	1	2	3	4	5
2	Mathematics is very interesting *Wiskunde is baie interessant*	1	2	3	4	5
3	Women are certainly logical enough to do well in mathematics *Vroue is beslis logies genoeg om goed te doen in wiskunde*	1	2	3	4	5
4	Mathematics helps to develop your mind and teaches you to think *Wiskunde help om jou verstand te ontwikkel en leer jou dink*	1	2	3	4	5
5	I have always enjoyed studying mathematics in school *Ek het nog altyd daarvan gehou om wiskunde op skool te doen*	1	2	3	4	5
6	I get a sinking feeling when I have to think about a hard maths problem *Ek kry 'n naarkol as ek aan 'n moeilike wiskundeprobleem moet dink*	1	2	3	4	5
7	Mathematics is boring, because it leaves no room for personal opinion *Wiskunde is vervelig, want dit laat nie ruimte vir persoonlike menings nie*	1	2	3	4	5
8	Mathematics doesn't scare me at all *Ek is glad nie bang vir wiskunde nie*	1	2	3	4	5
9	I would trust a woman just as much as a man to figure out important calculations *Ek het net soveel vertroue in 'n vrou as in 'n man om belangrike berekeninge uit te werk*	1	2	3	4	5
10	I am willing to use mathematics in a future job *Ek is gewillig om wiskunde in my toekomste beroep te gebruik*	1	2	3	4	5
11	Once I start working on a mathematical puzzle, I find it difficult to stop *As ek eers begin werk aan 'n wiskunderaaisel, is dit moeilik vir my om op te hou*	1	2	3	4	5
12	Men are naturally more interested in the sciences and women in the arts and social sciences *Mans is van nature meer geïnteresseerd in die wetenskappe en vroue in die kunste en sosiale wetenskappe*	1	2	3	4	5
13	I like mathematical problems that contain some challenge *Ek hou van wiskundeprobleme wat 'n sekere uitdaging bevat*	1	2	3	4	5
14	Too much emphasis is currently being placed on the importance of mathematics *Daar word deesdae te veel klem gelê op die belangrikheid van wiskunde*	1	2	3	4	5
15	I don't understand how some people can spend so much time on mathematics and seem to enjoy it *Ek kan nie verstaan hoe sommige mense so baie tyd aan wiskunde kan bestee en ook nog lyk asof hulle dit geniet nie*	1	2	3	4	5
16	Mathematics is less important than art or literature *Wiskunde is minder belangrik as kuns of letterkunde*	1	2	3	4	5