UNIVERSITY OF NAIROBI

COLLEGE OF BIOLOGICAL AND PHYSICAL SCIENCES

SCHOOL OF MATHEMATICS

ASSESSMENT OF STUDENTS' ATTITUDES IN SCIENCES IN SECONDARY SCHOOLS

USING MANOVA

KAMUKUNJI SUB-COUNTY

By

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I56/81020/2012

This research project is submitted to the University of Nairobi in partial fulfillment of the requirement for the degree of Masters of Science in Social Statistics

October 2014

Declaration

This is to certify that this research project is my original work and has not been presented for a degree award in any other University or institution of higher learning. Information from other sources has been duly acknowledged.

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I56/81020/2012

Signature Date

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Declaration by Supervisor

This project has been submitted for examination with my approval as supervisors

Dr. Nelson Owuor

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Signature Date

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Dedication

To God Almighty and My Family

Acknowledgement

I would like to express my special appreciation and thanks to my supervisors Dr. Nelson Owuor, and Dr. John Ndiritu, for the useful comments, remarks and engagement through the learning process of this Masters Project. You have been a tremendous mentor for me. Also, I like to thank the participants in my survey, who have willingly shared their precious time during the process of interviewing.

A special thanks to my family; my wife Teresia Maina, who spent sleepless nights with me and was always my support in the moments when there was no one to answer my queries, to my daughter Ruth Maina, and my son Timothy Maina, for all of the sacrifices that youǒve made on my behalf. Your prayers for me were what sustained me thus far. I would also like to thank all of my friends; Kinyua, and Mbugua who supported me in writing, and incented me to strive towards my goal.

Abstract

Attitude towards science subjects in secondary schools is one of the contributing factors to studentsô poor performance in sciences. This prompted the Government of Kenya through the ministry of education with assistance of the government of Japan through Japan International Agency (JICA) to undertake a programme to strengthen Mathematics and Science in Secondary Education (SMASSE).

We collected information on studentsô attitude towards science subjects by administering the Science Attitude as Modified from the Fennema-Sherman Attitude Scale. We applied the Multivariate Analysis of Variance (MANOVA) to evaluate the differences between attitude towards science of gender, school, form, overall performance and the subject of Biology, Chemistry and Physics.

The results showed that there was no significant difference between form twos and threes in attitude towards science subjects, that girls perceived science subjects as a male domain in comparison with boys , that girls schools had the highest scores in attitude than boys schools and that the students who perform best overall in all subjects had the highest scores in attitude towards science.

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1. INTRODUCTION

1.1 BACKGROUND

A Science subject is a pivot in the Kenyan secondary school curriculum, since careers such as medicine, engineering etc., depends on the science subjects and science subjects are gateway to many good paying jobs. The study of all science subjects involves pursuit of truth, a process that instills diligence patience and objectivity in learners. Science learning develops the scientific habits in students, which are transferable to other areas in life. Such habits involve non-reliance on superstition, use of critical thinking and respect for other people opinions. Studentsô achievement is influenced by favourable attitudes towards oneself as well as the subject (Deboer, 1987).

A student with positive self-concept of ability spends more time and energy in the subject thus gaining mastery of subject resulting in success. A study on the attitudes of the students towards Mathematics has shown that achievement in Mathematics, or any other subject, is determined by oneôs attitude towards the subject rather than oneôs attitudes being determined by oneôs achievement in the subject (Maritim, 1979)

The theoretical framework adopted in this study is based on theory of reasoned action (Fishbein, I. & Ajzen M., 1975). The theory explains that the beliefs represent the information that is known by an individual about the subject. Thus an individualôs attitude towards any subject is a function of that personôs beliefs about that object as well as the implicit evaluative responses associated with those beliefs. It could therefore be argued that beliefs affect attitudes and these attitudes affect the intentions and behaviours. The enhancement of positive self-concept of ability of a student in science will possibly in turn enhance the studentsô performance by fostering development of favourable attitudes towards the science subject.

Many students in Kenya choose to drop science subjects when given a choice and, even those who take them, performance are below average (Changeiywo, 2000; Aduda, 2003). The poor performance is evident from results, which compares the studentsô performance in science subjects. The findings show that the mean scores in Biology and Physics lies between 27 - 32%, while Chemistry lies between 25 - 26%. The overall performance is below average. These low marks in performance of science subjects may be a result of the attitudes held by students towards science subjects. Perhaps the poor performance in science subjects is the one that prompted the government through the Ministry of Education, with the assistance of the government of Japan through Japan International Cooperation Agency (JICA), to undertake a programme to Strengthen Mathematics and Science Secondary Education (SMASSE) (Changeiywo, 2000). This programme has been implemented in several Districts in Kenya but studentsô performance in science still remains low (KNEC, 2005). In response to the challenge posed by the poor performance and low enrolment in science, several studies have been carried out in Kenya to investigate the possible causes (Eshiwani, 1984; Kyalo, 1984; Mondoh, 1986; Wachanga, 2005). The majority of the studies centred on the instructional methods used by the teachers in teaching sciences and Mathematics. However, Haimowitz (1989) notes that the cause of most failures in schools might not be due to inadequate instruction but perhaps by active resistance by learners. Head (1988) emphasizes this argument by pointing out that students do not like sciences in most cases and therefore it is imperative that their feelings are considered alongside their thought

1.2 STATEMENT OF THE PROBLEM

Despite the efforts made by researchers to improve secondary school science curriculum, recent findings indicate that the level of sciences achievement among other subjects has remained persistently low (Ministry of Education [MOE], 2005). Researchers have identified many variables affecting student achievement. These include studentøs social-economic status, availability of learning resources, cultural context, family size, vocabulary of scientific terms and computation. The study therefore endeavoured to fill the gap by investigating the attitude that students have towards science subjects and its influence on academic achievement.

Mwamwenda (1995) argues that the achievement of students in a subject is determined by their attitudes towards the subject rather than the inability to study. All these arguments point to the important role that attitudes play in determining the achievement of any success. This therefore suggests that favourable attitudes towards sciences should be developed if success is to be attained. To be able to do this, a clear understanding of factors which influence formation of attitudes is essential.

This study therefore sought to investigate the attitudes held by learners towards science subjects and its influence on academic achievements

1.3 OBJECTIVES

The purpose of this study was to analyze some of the areas that may relate to a studentôs attitude toward science. The questions we sought to answer were:

1) To establish the impact of studentsô attitude towards science on science subjects performance.
2) To determine the significance difference between studentsô attitude towards science and studentsô overall performance, Gender, School and grade.

Previous to conducting our research, we expected to find girls having a more negative attitude toward science than boys and that girls would still consider science a male dominated field. We also suspected there would be a correlation between studentôs science subject performance and attitude toward science

2. REVIEW OF LITERATURE

There are many factors that contribute to a personøs attitude towards science subjects. These factors can assistance or deter a studentøs progress in sciences. Some of these factors are gender, perception of teacher attitudes toward the student as learner of science, confidence in learning sciences, stereotype of sciences as a male domain, and perceived usefulness of sciences. When these factors are combined, the total effect may be greater than the sum of the parts.

Eagly and Chaiken (2002) define attitudes as ñtendencies to evaluate an entity with some degree of favour or disfavor, ordinarily expressed in cognitive effective and behavioral responses.ö

Students can learn attitudes by modeling the behaviours of others (Aiken, 2002). Attitude can affect energy level, input, perseverance and engagement in an activity as indicated by Schreiber (2002).

Since the teaching-learning process also concerns itself with the promotion of desirable behaviour, education must draw some of its principles from psychology. This entails having a good grasp of all theories that influence the teaching and learning process. Attitudes associated with science appear to affect studentsô participation in science subjects and impacts in science (Linn, 1992). Further research on psychological effects has found that studentsô self-concept of ability to perform in science positively correlates with achievement. It has been observed that many students fear Chemistry. Such fear is characterized by mass disenchantment among the students towards the subject. The end product has been the declining popularity of the subject over the years. According to Keeves and Morgenstern (1992), studentsô anxiety towards the learning of Chemistry makes them lose interest in sciences.

On the other hand, Deboer (1987) points out that studentsô achievement is influenced by favourable attitudes towards oneself (positive self-concept) as well as the subject. A student with positive self-concept of ability in a subject has a higher probability of developing favourable attitudes towards that subject, and as a result spends more time and energy in the subject thus gaining mastery of the subject resulting in success. Deboer (1987) further argues that as a result of this success, the student is reinforced further to continue performing well in the subject possibly developing stronger favourable attitudes, towards the subject, resulting in a vicious cycle.

Mwamwenda (1995) argues that a personôs self-concept is a guide to their personality in terms of his or her own feelings, attitudes, psychological health and the way he or she is likely to interact with others in and outside his or her environment. Mwamwenda (ibid.) further points out that a pupil with a positive self-concept stands a better chance of performing better than a pupil with negative self-concept of ability. Thus it can be argued that enhancement of positive self-concept of ability of a student in science will possibly enhance the studentsô performance by fostering development of favourable attitudes towards Chemistry. However, care should be taken when interpreting results of a relationship between achievement and attitudes. This is because low achievement does not necessarily mean the students have unfavourable attitudes, towards science or any other subject for that matter.

Research has further shown that there is a positive correlation between attitudes and achievement; however, neither attitudes nor achievement is dependent on the other; rather they interact with each other in a complex and unpredictable way (Ajzen & Fishbein, 1975). Factors that influence studentsô attitudes towards a subject vary from one place to another. Furthermore, there are also other stronger predictor variables outside the school, which influence studentsô attitude towards a subject. These include parental influence and beliefs from ones culture (Muya, 2000). As such, the area pertaining to the attitudes towards sciences needs more research because the performance in Mathematics and Sciences is still low.

This lends more weight to the study conducted by Garrahy (2001), on three third-grade teachersô gender -related beliefs and behaviours, who found out that teacherôs attitudes towards the subject significantly, correlate with studentsô achievement. Thuo (1984) has investigated the relationship between teacherôs attitudes towards Mathematics and sciences and students achievement in Kiambu District Kenya. The findings of this study showed a positive correlation between teachersô attitudes towards Mathematics and Sciences and students achievement. These results were strengthened by the observation that the students who were taught by those teachers with negative attitudes had low achievement.

Another study by Kiragu (1988), on factors affecting achievement in Mathematics at secondary school level in Kenya, has established that teachersô qualification, quality of textbooks, frequency of marking and interest among students are significant. However, a critique by Kiragu (1988) on a similar study conducted earlier by Kathuri and Pals (1993) asserts that the significant relationship between studentsô attitudes towards a subject and academic achievement is a function of their personal attitudes rather than external factors, which may influence them. As such, the conclusions on the above studies were not sufficiently adequate as they were only based on teachers influence on studentsô attitudes towards mathematics. Similarly, it is also difficult to go by Kiraguôs (ibid.) critique when handling similar findings from research settings conducted in other study areas. This is because factors which influence teachersô attitudes towards a subject vary from one place to another.

Furthermore, there are also stronger predictor variables outside the school, which influence studentsô attitudes towards a subject. These include parental influence and beliefs from ones culture. Hence the area pertaining to attitudes towards Mathematics and Sciences needs more research since studentsô achievement is still low. In other instances, there have been controversies as to why girls and boys perform differently in Mathematics and Sciences (Dawrey & Watson, 1995) and (Watson, 1995). An important issue is the relationship between studentsô attitudes and the instructional contexts. Do different instructional contexts influence studentsô attitudes and do different attitudes result in different opportunities of learning and achievement? Research from different countries with different educational systems and curricula will provide an opportunity to identify the relationship between studentsô attitudes and instructional contexts of these countries. The majority of the existing studies concern attitudes towards science in general. Only few studies attitudes toward a particular discipline like Biology and Physics and only two towards Chemistry have been conducted (Menis, 1989).

Ramsden (1998) has pointed out the use of ñScienceò as an umbrella term to encompass Biology, Physics and Chemistry. It has been suggested that the research of studentsô attitudes must focus on separate disciplines within science rather than on Science, because students (girls in particular) respond more to Biological sciences than Physical sciences. Menis (1989) further argues that the assessment of studentsô attitude towards Sciences should be concerned with at least three distinct referents. He identifies these three referents as an attitude towards the importance of Science, an attitude towards Science as a career, and an attitude towards Science in school curriculum. Their attitudes regarding the difficulty of science lessons are related to concepts, symbols and problem solving. It seems that students find the use and application of science concepts and symbols more difficult than their understanding.

Some attitudes have been shown to be more attributable to one gender or other. In Fennema and Shermanǿs (1977) original study, they found that girls had lower confidence than boys, even when girls had the same or better scores on an achievement test (Wilson & Hart, 2001).

3. METHODOLOGY

3.1 Population and Sampling

According to Kombo and Tromp (2006) the total collection of the respondents under investigation will constitute the target study population while a sample is a representative proportion of the population who are investigated in the study. In the current study the target population will be 3350 students from the day six day schools in Kamukuji district. The day schools were chosen so that they can act as the true representative of Kamukuji residents. National schools were excluded since they have a national intake of students in form one.

Table 3.1: Population of the Study

School	Population
School 1	503
School 2	742
School 3	898
School 4	362
School 5	492
School 6	353
	3350

Purpose sampling was done to determine which form to include in the study. Form 2 and Form 3 classes were selected. Simple random sampling was used to select respondents. The method was used since it would ensure that every student have an equal chance of being selected without biasness. The following formula (Joachim Otte, 2002) will be used to calculate the total sample size to be used in the study.

$$n= \{z^2 \text{ x } (p \text{ x } q)/d^2\}$$

Where; n = Sample size,
Z = 95% confidence interval (z=1.96),
p = expected prevalence (as a fraction of 1),
q = 1-p (expected non prevalence),
d= (desired precision).

$$n= \{1.96^2 \text{ x } (0.95 \text{ x } 0.05)/0.03^2\} = 203.$$

Table 3.2 Sample Size

		Form		Total
		Form2	Form3	
school	school1	25	25	50
	school2	23	20	43
	school3	24	20	44
	school4	22	20	42
	school5	22	14	36
	school6	21	18	39
Total		137	117	254

Table 3.1, Shows the sample sizes for each school and form 2 and form 3 sample sizes selected in each school allowing for 25% non response.

3.2 Design of the Study

This study was designed to compare studentsô attitudes about sciences in form 2 and form 3 by Biology, physics, and chemistry performance, gender and schools. The Modified Fennema-Sherman Attitude Scales was used. The attitudes measured are confidence in learning mathematics, perceived usefulness of sciences, stereotype of sciences as a male domain, and perception of teacher attitudes toward the student as a learner of sciences. Each of the four subscales had 12 statements, except for the scale measuring if the subject is perceived as a male domain, which only had 11 statements. For the attitude subscales with 12 statements, six of those statements were considered positive and six were considered negative. In the case of the male dominance subscale, six statements were considered positive, and only five were considered negative. The survey used a Likert scale.

Each survey was scored in each of the four areas: perception of teacher attitudes towards a student as a learner of sciences, confidence in learning sciences, perceived usability of sciences, and stereotype of sciences as a male domain. Each survey statement provided five responses on a Likert-style rating scale (A=strongly agreed; B=agreed; C= not sure; D= disagreed; E=strongly disagreed). Statements positively worded were assigned numbers in descending order (A=5, B=4, C=3, D=2, E=1); statements negatively worded were assigned numbers in ascending order (A=1, B=2, C=3, D=4, E=5).

An overall score was then calculated for each subscale by simply adding the scores from the positive and negative statements for each subscale. The highest score for each subscale was 60, except for the scale of male dominance, which had a high score of 55. The scores for these four attitude subscales were then used as dependent variables in our study. We also inquired about demographic information including sex, class, major (only those taking three sciences were sampled in form 3), three consecutive end of term grades in the Biology, Physics Chemistry and overall mean grade, and school the student is attending (boys, girls or mixed). Studentôs average marks for the three terms were used to create five percentile scales variables for Biology, Chemistry, Physics and overall grade.

The demographic items were then used as independent variables. To analyze the data, a Multivariate Analysis of Variance (MANOVA) was conducted for each independent variable (sex, form, Biology, chemistry, physics and overall percentile grades), with the four dependent variables of confidence, usefulness, male dominance, and perception of teacher attitudes. The results for each where then analyzed for significance using Wilksô Lambda, with an alpha value of 0.05. For tests having significance, a One-Way Analysis of Variance (ANOVA) was then conducted, followed by pairwise or multiple comparisons to find the source of the differences and significance. The surveys were conducted throughout the second term of 2014 at public schools in Kamukunji District, Nairobi County. Students participating in the study were enrolled in all of the following sciences: BIOLOGY, CHEMISTRY, and PHYSICS.

The surveys were given during the respective subject lessons with assistance of the respective subject teacher. Participation in the study was strictly voluntary. Students indicated their agreement to participate in the study by completing the survey. Prior to giving the survey, consent was obtained from the six schools principals.

3.2 MANOVA

Multivariate analysis explore outcome from several parametric depended variables, across one or more independent variables (each with at least two distinct groups or conditions). With multivariate analyses there are at least two dependent variables and tests are inform of Multivariate Analysis of Variance (MANOVA) where the dependent variables outcomes relate to a single point in time. (Mayers, 2013).

Assumptions and Restrictions

There are a number of conditions that we should consider before performing MANOVA. The assumptions and restrictions for MANOVA are;

- The independent variable(s) must be categorical, with at least two groups
- The dependent variable data must be interval or ratio, and be reasonably normally distributed
- There should not be too many outliers
- There should be reasonable correlation between the dependent variables
    - Positive correlation should not exceed r=0.90
    - Negative correlation should not exceed r=-0.40
- There should be between-group homogeneity of variance
- Correlation between dependent variables should be equal between the groups

Two estimates of the population variance in a one-way ANOVA are termed *mean squares*. Computationally, mean squares denote the quantity resulting from dividing the sum of squares by its associated degrees of freedom. The between group mean squares--which will now be called the *hypothesis* mean squares, is

$$MS_H = \frac{SS_H}{df_H}$$

And the within group mean squares--which will now be called the error mean squares, is

.

[illegible]

The *F* statistic for any hypothesis is defined as the mean squares for the hypothesis divided by the mean squares for error. The *F* statistic is the product of two ratios. The first ratio is the degrees of freedom for error divided by the degrees of freedom for the hypothesis. The second ratio is the sum of squares for the hypothesis divided by the sum of squares for error. That is,

[illegible]

The *A* statistic is simply the *F* statistic multiplied by the degrees of freedom for the hypothesis and divided by the degrees of freedom for error, or

[illegible]

The *A* statistic defined above is simply the ratio of the sum of squares for a hypothesis and the sum of squares for error. Let **H** denote the hypothesis sums of squares and cross products matrix, and let **E** denote the error sums of squares and cross products matrix. The multivariate equivalent of the *A* statistic is the matrix **A** which is

$$\mathbf{A} = \mathbf{H}\mathbf{E}^{-1} \tag{3.2.1}$$

Because both **H** and **E** are symmetric, $\mathbf{H}\mathbf{E}^{-1} = \mathbf{E}^{-1}\mathbf{H}$.

3.3. Hypothesis Testing in MANOVA

All current MANOVA tests are made on $\mathbf{A} = \mathbf{E}^{-1}\mathbf{H}$. There are four different multivariate tests that are made on $\mathbf{E}^{-1}\mathbf{H}$. Each of the four test statistics has its own associated *F* ratio. In some cases the four tests give an exact *F* ratio for testing the null hypothesis and in other cases the *F* ratio is approximated.

Assume that there are *q* dependent variables in the MANOVA, and let λ_i denote the i^{th} eigen-value of matrix **A** which is equals $\mathbf{H}\mathbf{E}^{-1}$.

The first statistic is *Pillai's trace*. Some statisticians consider it to be the most powerful and most robust of the four statistics. The formula is

$$\text{Pillai's trace} = \text{trace}[\mathbf{H}(\mathbf{H} + \mathbf{E})^{-1}] = \sum \frac{\lambda_i}{1 + \lambda_i}. \quad (3.2.2)$$

The second test statistic is *Hotelling-Lawley's trace*.

$$\text{Hotelling-Lawley's trace} = \text{trace}(\mathbf{A}) = \text{trace}(\mathbf{HE}^{-1}) = \sum^{q} \lambda_I \quad . (3.2.3)$$

The third is *Wilk's lambda* (Λ). (Here, the upper case, Greek Λ is used for Wilk's lambda to avoid confusion with the lower case, Greek λ often used to denote an eigen-value.) Wilk's Λ was the first MANOVA test statistic developed and is very important for several multivariate procedures in addition to MANOVA.

$$\text{Wilk's lambda} = \Lambda = \frac{|\mathbf{E}|}{|\mathbf{H} + \mathbf{E}|} = \prod \frac{1}{1 + \lambda_i} \quad . (3.2.4)$$

The quantity (1 - Λ) is often interpreted as the proportion of variance in the dependent variables explained by the model effect. However, this quantity is not unbiased and can be quite misleading in small samples.

The fourth and last statistic is *Roy's largest root*. This gives an upper bound for the *F* statistic.

$$\text{Roy's largest root} = \max(\lambda_i). \quad (3.2.5)$$

or the maximum eigen-value of $\mathbf{A} = \mathbf{HE}^{-1}$. This statistic could also be called Roy's largest eigen-value.

All the formula in equations (3.2.2) through (3.2.5) are based on the eigen-values of $\mathbf{A} = \mathbf{HE}^{-1}$. This is the major reason why statistical programs such as SAS print out the Eigen-values and eigenvectors of $\mathbf{A} = \mathbf{HE}^{-1}$.

Once the statistics in (3.2.2) through (3.2.5) are obtained, they are translated into *F* statistics in order to test the null hypothesis. The reason for this translation is identical to the reason for converting Hotelling's T^2--the easy availability of published tables of the *F* distribution. In some cases, the *F* statistic is exact and in other cases it is approximate. Statistical packages inform whether the *F* is exact or approximate. In some cases, the four will generate identical *F* statistics and identical probabilities. In other's they will differ. When they differ, Pillai's trace is often used because it is the most powerful and robust. Because Roy's largest root is an upper bound on *F*, it will give a lower bound estimate of the probability of *F*. Thus, Roy's largest root is generally disregarded when it is significant but the others are not significant (Gregory Carey, 1998).

To test if the vector of means of the dependent variables is equal for multiple independent groups

The null hypothesis for MANOVA is

$$H_0 : \begin{bmatrix} \overline{X}_{11} \\ \overline{X}_{21} \\ \vdots \\ \overline{X}_{p1} \end{bmatrix} = \begin{bmatrix} \overline{X}_{12} \\ \overline{X}_{22} \\ \vdots \\ \overline{X}_{p2} \end{bmatrix} = \begin{bmatrix} \overline{X}_{13} \\ \overline{X}_{23} \\ \vdots \\ \overline{X}_{p3} \end{bmatrix} = \cdots = \begin{bmatrix} \overline{X}_{1k} \\ \overline{X}_{2k} \\ \vdots \\ \overline{X}_{pk} \end{bmatrix}$$

where p represents the total number of dependent variables (4 Science attitude),for k levels (factors).

- For MANOVA, our test statistic is computed as:

$$\Lambda = \frac{|\boldsymbol{W}|}{|\boldsymbol{T}|} = \frac{|\boldsymbol{W}|}{|\boldsymbol{B} + \boldsymbol{W}|}$$

- where W and T are determinants of the within and total sum of squares and cross-product matrices (Kyle Roberts, 2009).

$$\Lambda = \frac{|W|}{|B + W|}$$

where

$$W = \sum_{i=1}^{k} \sum_{j=1}^{n} (X_{ij} - \dot{X}_{i})(X_{ij} - \dot{X}_{i})'$$

Where *i* =1,2 ,é é é .k j=1,2,3,é é é é .n

$$B = \sum_{i=1}^{k} n_{i}(\dot{X}_{i} - \dot{X}_{..})(\dot{X}_{i} - \dot{X}_{..})'$$

Where *i* = 1,2,3,é é é é é é é k

4. RESULTS AND ANALYSIS

4.1 Exploratory data analysis

For our study, the sample size consisted of 254 students. Of these students, 166 were male (65%) and 88 were female (35%). Out of our sample 137 were form two students (54%) and 117 form three students (46%).

In tables the following codes were used to represent the respective attitudes;

- Confidence = ñConfident in learning Sciencesò
- Male dominance = ñStereotypes of science as male domainò
- Teacher perception = ñTeacher attitudes towards a student as a learner of sciencesò
- Usefulness = ñPerception usability of scienceò

4.1.1 Checking correlation

Before the main test, magnitude of correlation between the dependent variables was checked.

Table 4. 1 Correlation between attitudes towards science subjects.

		Confidence	**Male Domain**	**Teacher Perception**	**Usefulness**
	N	254	254	254	254
Confidence	Pearson Correlation	1	0.209	0.587	0.719
	Sig. (2-tailed)		0.001	0	0
Male Domain	Pearson Correlation	0.209	1	0.312	0.285
	Sig. (2-tailed)	0.001		0	0
Teacher Perception	Pearson Correlation	0.587	0.312	1	0.555
	Sig. (2-tailed)	0	0		0
Usefulness	Pearson Correlation	0.719	0.285	0.555	1
	Sig. (2-tailed)	0	0	0	

The correlation shown in Table 4.1 is within acceptable limits for MANOVA outcomes, as earlier discussed, in assumptions and restriction (sub-section 3.2.1).

4.1.2 Test for normal distribution

Table 4.2 shows Kolmogorov-Smirnov/Shapiro-Wilk test for the attitude scores.

Table 4.2 Tests of Normality for attitudes

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Confidence	0.095	254	0.000	0.960	254	0.000
Male dominance	0.080	254	0.001	0.973	254	0.000
Teacher perception	0.081	254	0.000	0.976	254	0.000
Usefulness	0.117	254	0.000	0.928	254	0.000

The total for all the 4 attitude scores, are very significant. Thus they are reasonably normally distributed. The Q-Q plots for the four attitude scores are shown in Figure 4.1 ï 4.4. From the Q-Q we can tell that outliers were very few.

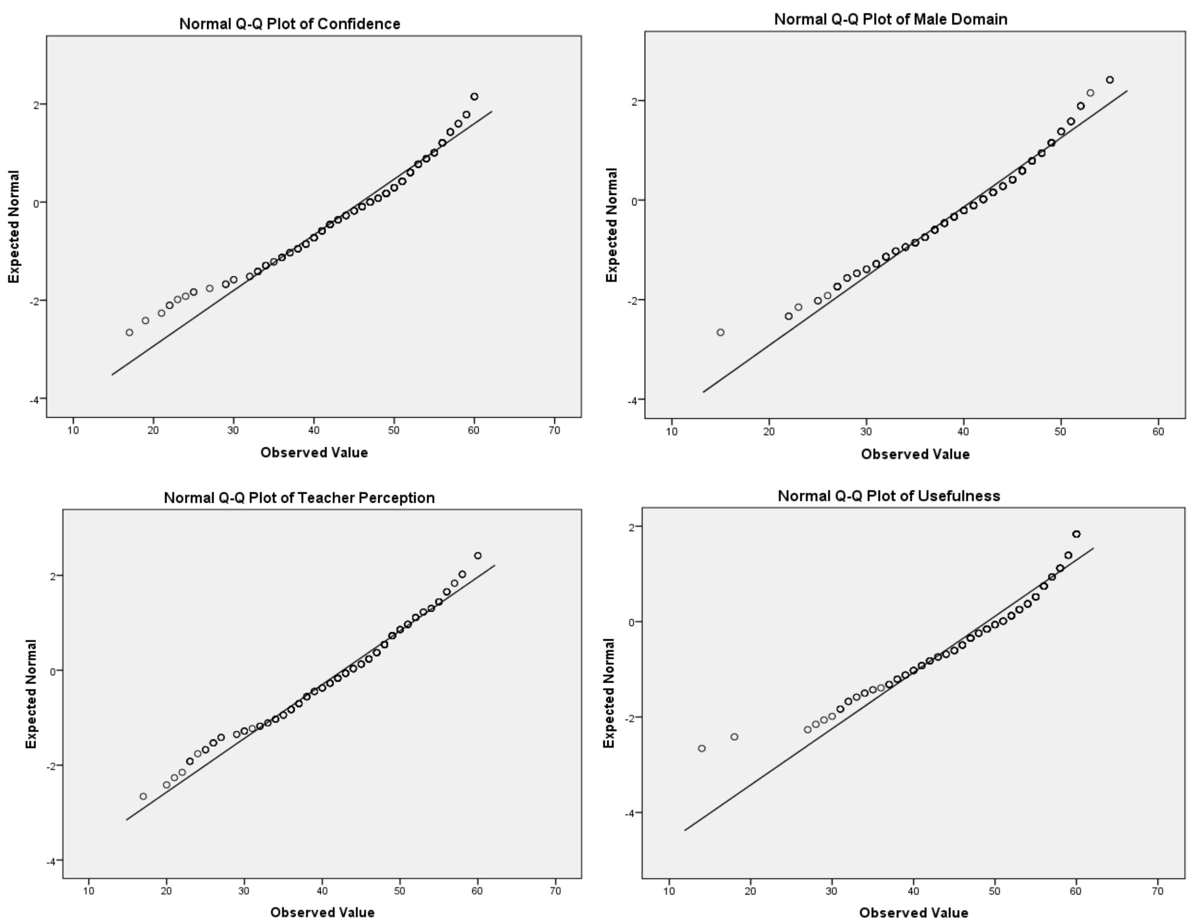

Figure 4.1 – 4. 4 Q-Q plots of attitude towards science scores

4.2 Multivariate Analysis of Variance (MANOVA)

4.2.1 Attitudes towards Sciences by Gender

Attitudes on confidence in learning sciences, stereotypes of sciences as male domain, teacher attitudes towards a student as a learner of sciences and perceived usability of sciences were measured in two groups of gender: Girls and Boys.

Table 4.3 indicate that we have homogeneity of between-group variance for usefulness scores and Teacher perception scores (significance > 0.05), but not for Confidence scores and Male dominance scores (significance < 0.05).

Table 4. 3 Leven's test for equality of variances for Gender

	F	df1	df2	Sig.
Confidence	10.071	1	252	0.002
Male dominance	16.996	1	252	0.000
Teacher perception	0.959	1	252	0.328
Usefulness	3.199	1	252	0.075

Due to none significance of the two attitude scores: Confidence and Male dominance, further tests (Brown-Forsythe F or Welchôs F statistics) were done when we used independent one-way ANOVA to explore the univariate outcome, to address the violation of homogeneity in Confidence and Male dominance studentôs attitudes.

Table 4.4 Attitude towards sciences scores by Gender

		Confidence		Usefulness		Teacher Perception		Male Domain	
Gender	N	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Boys	166	45.37	9.644	48.14	8.94	42.23	9.129	38.43	6.999
Girls	88	46.84	6.95	50.75	7.291	43.48	8.203	45.81	4.648
Total	254	45.88	8.818	49.04	8.483	42.66	8.823	40.99	7.193

These initial statistics (presented in Table 4.4) *suggest* that girls are more confidence in learning sciences than boys, girlsô perceived usability of sciences more than boys; girls are affected more by teachersô attitudes towards a student as a learner of science than boys and girls stereotypes science as a male domain more than boys.

Table 4.5 below presents MANOVA statistics. MANOVA analyses confirmed that there was a significant multivariate effect for the combined dependent variables: ə=0.749, F=20.833, P < 0.001 (highlighted in bold in Table 4.5).

Table 4.5 MANOVA statistics for Gender

Effect		Value	F	Hypothesis df	Error df	Sig.
Gender	Pillai's Trace	0.251	20.833[b]	4	249	0.000
	Wilks' Lambda	**0.749**	**20.833[b]**	4	249	**0.000**
	Hotelling's Trace	0.335	20.833[b]	4	249	0.000
	Roy's Largest Root	0.335	20.833[b]	4	249	0.000

Univariate independent one-way ANOVAs (Table 4.6), showed two attitudes towards sciences; stereotypes of sciences as a male domain and perceived usability of sciences, differed significantly in respect of the independent variable (Gender of the student): Male dominance: F(1,252) = 79.084, P < 0.001, Usefulness: F (1,252) = 5.549, P = 0.019.

Table 4.6 ANOVA for Gender

Dependent Variable		Sum of Squares	df	Mean Square	F	Sig.
Confidence	Contrast	123.841	1	123.841	1.596	0.208
	Error	19548.616	252	77.574		
Male Domain	Contrast	3126.478	1	3126.478	79.084	**0.000**
	Error	9962.487	252	39.534		
Teacher Perception	Contrast	89.626	1	89.626	1.152	0.284
	Error	19605.256	252	77.799		
Usefulness	Contrast	392.210	1	392.210	5.549	**0.019**
	Error	17812.313	252	70.684		

Confidence in learning science and Teacher attitudes towards a student as a learner of sciences didnôt differ significantly in respect of gender: Confidence: F (1,252) = 1.596, P = 0.208: Teacher Perception: F(1,252) = 1.152, P = 0.284. As we know that we had a problem with the homogeneity of variance for Male dominance scores across gender groups (Table 4.3), we examined those scores again, using an independent one-way ANOVA with Brown-Forsythe F and Welchôs F adjustments.

Table 4.7 ANOVA for Gender with Brown-Forsythe F and Welch's F adjustments

		Sum of Squares	df	Mean Square	F	Sig.
Confidence	Between Groups	123.841	1	123.841	1.596	0.208
	Within Groups	19548.616	252	77.574		
	Total	19672.457	253			
Male Domain	Between Groups	3126.478	1	3126.478	79.084	0.000
	Within Groups	9962.487	252	39.534		
	Total	13088.965	253			

Table 4.7 confirms what we saw in Table 4.5: unadjusted one-way ANOVA outcome, Male dominance: F (1,252) = 79.084, P < 0.001, Confidence: F (1,252) = 1.596, P = 0.208.

Table 4.8 Robust Tests of Equality of Means for Gender

		Statistic[a]	df1	df2	Sig.
Confidence	Welch	1.941	1	229.303	0.165
	Brown-Forsythe	1.941	1	229.303	0.165
Male Domain	Welch	100.555	1	239.436	0.000
	Brown-Forsythe	100.555	1	239.436	0.000

a. Asymptotically F distributed.

Table 4.8 shows the revised outcome, adjusted by Brown-Forsythe F and Welchǒs F statistics. There is still a highly significant difference in Male across gender, Welch: F (1,239.436) = 100.555, P < 0.001. The violation of homogeneity of variance poses no threat to the validity of our results. Confidence across gender, Welch: F (1,229.303), P =0.165. Thus for confidence data need to be interpreted with caution since it failed the tests.

4.2.2 Attitudes towards Sciences by Schools

Attitudes on confidence in learning sciences, stereotypes of sciences as male domain, teacher attitudes towards a student as a learner of sciences and perceived usability of sciences were measured in six different schools.

Table 4.9: Attitude towards sciences scores by Schools

School	N	Confidence		Male Domain		Teacher Perception		Usefulness	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
School 1	50	46.18	9.589	41.16	6.368	42.08	10.178	50	8.711
School 2	43	43.16	11.596	37.09	6.297	41.21	9.961	46.26	10.24
School 3	44	47.27	8.737	37.64	7.221	42.8	8.034	48.77	8.302
School 4	42	49.24	6.234	46.69	4.425	44.74	8.721	52.21	6.752
School 5	36	44.39	6.834	45.22	4.223	43.44	6.678	50.56	7.165
School 6	39	44.69	7.241	38.79	7.981	41.9	8.372	46.38	7.762

Schools were coded 1 to 6 for confidentiality which was assured when collecting data at those schools. These initial statistics (presented in Table 4.9) *suggest* that school 4 had the highest scores in all the four attitudes towards sciences than other schools and school 2 had the least.

Table 4.10 indicate that we have homogeneity of between-group variance for usefulness scores and Teacher perception scores (significance > 0.05), but not for Confidence scores and Male dominance scores (significance < 0.05).

Table 4.10: Leven's test for equality of variances for Schools

	F	df1	df2	Sig.
Confidence	5.780	5	248	0.000
Male Domain	4.625	5	248	0.000
Teacher Perception	1.943	5	248	0.088
Usefulness	1.435	5	248	0.212

Due to none significance of the two attitude scores: Confidence and Male dominance, further tests (Brown-Forsythe F or Welchӧs F statistics) were done when we used independent one-way ANOVA to explore the univariate outcome, to address the violation of homogeneity in Confidence and Male dominance studentӧs attitudes (Similarly as in subsection 4.2.1).

Table 4. 11 MANOVA statistics for Schools

	Value	F	Hypothesis df	Error df	Sig.
Pillai's trace	0.341	4.626	20.000	992.000	0.000
Wilks' lambda	**0.677**	**5.067**	20.000	813.523	**0.000**
Hotelling's trace	0.449	5.465	20.000	974.000	0.000
Roy's largest root	0.380	18.872[a]	5.000	248.000	0.000

The four studentsô attitudes towards sciences were measured in six schools: school 1 to school 6. MANOVA analysis (Table 4.11) showed that there was significant multivariate effect: ə=0.677, F(5,248)= 5.067, $P < 0.001$.

Univariate independent one-way ANOVAs (Table 4.12) showed significant main effects for schools in respect of Confidence: F (5,248) = 2.701, P = 0.021, Male domain: F (5,248) = 17.040, $P < 0.001$, and Usefulness: F (5,248) = 3.386, P = 0.006. But there was no significant main effect for schools in respect to Teacher perception: F (5,248) = 0.857, P = 0.511.

Table 4.12 ANOVA of attitudes towards sciences scores by Schools

Dependent Variable		Sum of Squares	df	Mean Square	F	Sig.
Confidence	Contrast	1016.007	5	203.201	**2.701**	**0.021**
	Error	18656.450	248	75.228		
Male Domain	Contrast	3346.877	5	669.375	**17.040**	**0.000**
	Error	9742.087	248	39.283		
Teacher Perception	Contrast	334.329	5	66.866	0.857	0.511
	Error	19360.553	248	78.067		
Usefulness	Contrast	1163.419	5	232.684	**3.386**	**0.006**
	Error	17041.104	248	68.714		

As we know that we had a problem with the homogeneity of variance for Male dominance scores and confidence scores across gender groups (Table 4.10), we examined those scores again, using an independent one-way ANOVA with Brown-Forsythe F and Welchôs F adjustments.

Table 4.13 Unadjusted ANOVA outcome for Schools

		Sum of Squares	df	Mean Square	F	Sig.
Male Domain	Between Groups	3346.877	5	669.375	17.040	0.000
	Within Groups	9742.087	248	39.283		
	Total	13088.965	253			
Confidence	Between Groups	1016.007	5	203.201	2.701	0.021
	Within Groups	18656.450	248	75.228		
	Total	19672.457	253			

Table 4.14 Adjusted outcomes for homogeneity of variance for Schools

		Statistic[a]	df1	df2	Sig.
Male Domain	Welch	22.446	5	114.189	0.000
	Brown-Forsythe	17.235	5	209.017	0.000
Confidence	Welch	3.472	5	114.567	0.006
	Brown-Forsythe	2.779	5	214.020	0.019

a. Asymptotically F distributed.

Table 4.13 confirms what we saw in Table 4.11: unadjusted one-way ANOVA outcome, Male domain: F (5,248) = 17.040, P < 0.001, Confidence: F (5,248) = 2.701, P = 0.021. Table 4.14 shows the revised outcome, adjusted by Brown-Forsythe F and Welchȏs F statistics. There is still a highly significant difference in Teacher attitude s towards a student as a learner of sciences across gender, Welch, Male domain: F (5,114.189) = 22.446, P < 0.001, Confidence: F (5,114.567) = 3.472, P = 0.06. Thus minor violation in homogeneity of between-group variance for Students attitude towards sciences scores had no impact on the observed outcome.

Game-Howell *post hoc* tests showed that students Confidence in learning sciences attitude in school 4 was significantly different with school 2 (P = 0.041), school 5 (P = 0.021) and school 6 (P = 0.039). Stereotype of sciences as a male domain attitude in school 4 was highly significantly different with school 1 (P < 0.001), school 2 (P < 0.001), school 3 (P < 0.001), and school 6 (P < 0.001). School 5 was significantly different with all school except school 4.

Tukey analyses showed that Teacher perception attitude there was no significant different in all schools. Perceived usability of sciences attitude in school 2 was significantly different with school 4 (P = 0.013). School 4 was significantly different with school 6 (P = 0.022).

4.2.3 Attitudes towards Sciences by Form

Attitudes on confidence in learning sciences, stereotypes of sciences as male domain, teacher attitudes towards a student as a learner of sciences and perceived usability of sciences were measured in two Forms: Form 2 and Form 3.

Table 4.15 Attitude towards sciences scores by forms

Form	N	Confidence		Male Domain		Teacher Perception		Usefulness	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Form2	137	45.16	9.452	40.48	7.481	42.85	9.15	48.89	9.214
Form3	117	46.73	7.969	41.58	6.823	42.44	8.457	49.22	7.573

These initial statistics (presented in Table 4.15 and Figure 4.5) *suggest* that form 3 students had the more confidence in learning sciences than form 2 students, form 3 students had more stereotypes of sciences as a male domain more than form 2 students, form 2 students are affected more by teachersô attitudes towards a student as a learner of science than form 3 students and form 3 students perceived usability of sciences more than form 2 students.

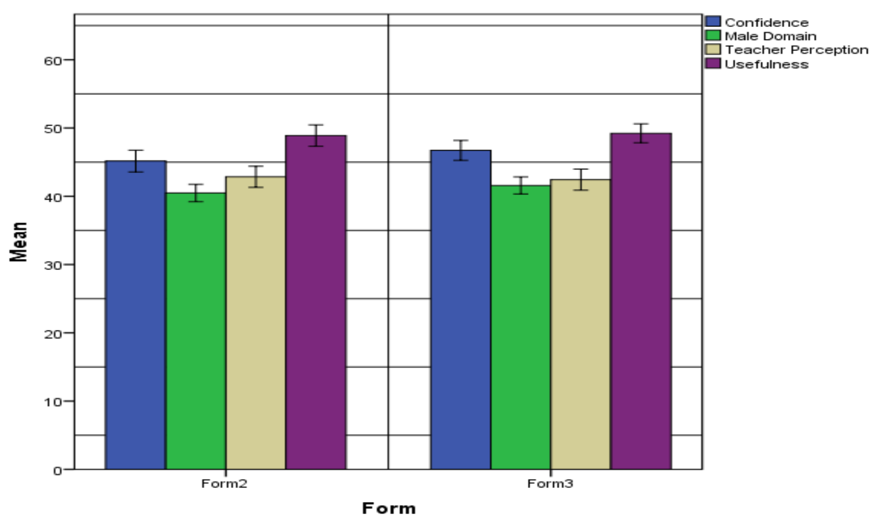

Figure 4.5 Attitude towards sciences scores by form

Table 4.16 indicate that we have homogeneity of between-group variance for all four attitude towards sciences scores (significance > 0.05).

Table 4.16 Leven's test for equality of variances for Forms

	F	df1	df2	Sig.
Confidence	2.776	1	252	0.097
Male Domain	1.083	1	252	0.299
Teacher Perception	1.133	1	252	0.288
Usefulness	2.781	1	252	0.097

Table 4.17 MANOVA statistics for Forms

	Value	F	Hypothesis df	Error df	Sig.
Pillai's trace	0.027	1.713	4.000	249.000	0.148
Wilks' lambda	**0.973**	**1.713**	4.000	249.000	**0.148**
Hotelling's trace	0.028	1.713	4.000	249.000	0.148
Roy's largest root	0.028	1.713	4.000	249.000	0.148

The four studentsô attitudes towards sciences were measured in both forms: Form 2 and Form 3. MANOVA analysis (Table 4.17) showed that there was **No** significant multivariate effect: ə=0.973, F (1,252) = 5.067, P = 0.148.

Table 4.18 ANOVA for Forms

Dependent Variable		Sum of Squares	df	Mean Square	F	Sig.
Confidence	Contrast	154.742	1	154.742	1.998	0.159
	Error	19517.715	252	77.451		
Male Domain	Contrast	76.282	1	76.282	1.477	0.225
	Error	13012.683	252	51.638		
Teacher Perception	Contrast	11.032	1	11.032	.141	0.707
	Error	19683.850	252	78.111		
Usefulness	Contrast	6.944	1	6.944	.096	0.757
	Error	18197.580	252	72.213		

Univariate independent one-way ANOVAs (Table 4.18) confirmed our multivariate analysis results, showed that all attitudes towards sciences **didn't** differed significantly in respect of the independent variable, form (School grade): all P-values > 0.05.

4.2.4 Attitudes towards Sciences by Overall Performance of the Student

Attitudes on confidence in learning sciences, stereotypes of sciences as male domain, teacher attitudes towards a student as a learner of sciences and perceived usability of sciences were measured in five different quintiles of the studentôs average overall mean grade.

Studentôs overall mean grades for previous three consecutive terms we averaged and five rank quintiles (A = Highest quintile rank to E = Lowest quintile rank), were generated from the students average mean grade and each student was assigned his/her respect quintile grade. This was necessary since schools had different grading system.

Table 4.19 Attitude towards sciences scores by overall performance of students

Overall Mean Grade	N	Confidence		Male Domain		Teacher Perception		Usefulness	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
A	49	48.78	6.983	43.06	6.306	44.98	8.425	51.43	6.801
B	50	47.02	7.734	42.14	7.516	43.18	8.344	50.90	6.488
C	52	45.08	8.345	41.35	7.603	42.83	8.708	48.13	8.552
D	51	44.75	9.432	39.35	6.797	40.90	8.307	47.76	9.395
E	52	43.98	10.515	39.17	7.09	41.54	9.958	47.17	9.921

These initial statistics (presented in Table 4.19 and Figure 4.6) *suggest* that the overall brightest students (based on overall performance) had the highest scores in all the four attitudes towards sciences. All attitude scores means dropped as the performance dropped from rank A up to the least rank E.

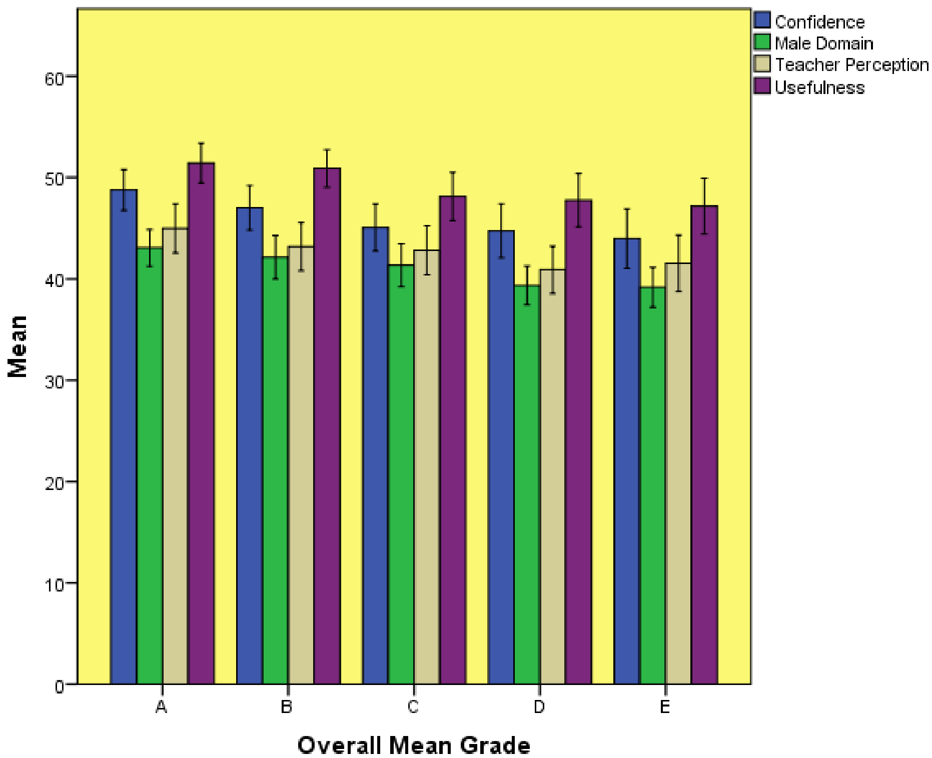

Figure 4.6 Attitude towards sciences scores by Student's Overall Mean Grade

Table 4.20 MANOVA statistics for overall performance of students

	Value	F	Hypothesis df	Error df	Sig.
Pillai's trace	0.084	1.340	16.000	996.000	0.165
Wilks' lambda	**0.917**	**1.357**	16.000	752.180	**0.157**
Hotelling's trace	0.090	1.370	16.000	978.000	0.149
Roy's largest root	0.075	4.654[a]	4.000	249.000	0.001

The four studentsô attitudes towards sciences were measured in all overall grade performance ranks: A to E. MANOVA analysis (Table 4.20) showed that there was **No** significant multivariate effect: ǝ=0.917, F (4,249) = 1.357, P = 0.157.

Table 4.21 ANOVA Statistics for overall performance of students

Dependent Variable		Sum of Squares	df	Mean Square	F	Sig.
Confidence	Contrast	762.587	4	190.647	**2.510**	**0.042**
	Error	18909.870	249	75.943		
Male Domain	Contrast	591.270	4	147.817	**2.945**	**0.021**
	Error	12497.695	249	50.192		
Teacher Perception	Contrast	501.647	4	125.412	1.627	0.168
	Error	19193.235	249	77.081		
Usefulness	Contrast	759.347	4	189.837	**2.710**	**0.031**
	Error	17445.176	249	70.061		

Univariate independent one-way ANOVAs (Table 4.21), showed three attitudes towards sciences; Studentôs confidence in learning sciences, Stereotypes of sciences as a male domain attitude and perceived usability of sciences attitude, differed significantly in respect of the independent variable (Studentôs overall performance): Confidence: F (4,249) = 2.510, P = 0.042, Male dominance: F(4,249) = 2.945, P = 0.021, Usefulness: F (4,249) = 2.945, P = 0.031. Teacher attitude towards a student as a learner of sciences attitude was not significant.

4.2.5 Attitudes towards Sciences by Performance of the Student in Biology Subject.

Attitudes on confidence in learning sciences, stereotypes of sciences as male domain, teacher attitudes towards a student as a learner of sciences and perceived usability of sciences were measured in five different quintiles of the studentôs average grade in Biology subject.

Studentôs Biology marks for previous three consecutive terms we averaged and five rank quintiles (A = Highest to E = Lowest quintile rank), were generated from the students average marks and each student was assigned his/her respect quintile grade in Biology subject.

Table 4.22 Attitude towards sciences scores for Biology subjects

Biology Grade	N	Confidence		Male Domain		Teacher Perception		Usefulness	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
A	50	48.64	6.859	43.64	6.645	44.74	8.063	51.62	7.143
B	52	47.21	8.11	41.77	6.941	43.25	9.322	50.06	8.192
C	50	45.42	9.139	40.74	6.602	42.26	8.020	48.90	9.083
D	51	46.90	9.091	40.51	7.540	43.65	8.834	48.82	8.525
E	51	41.25	9.121	38.31	7.385	39.43	9.166	45.84	8.596

These initial statistics (presented in Table 4.22) *suggest* that the brightest students in Biology subject had the highest scores in all the four attitudes towards sciences. All attitude scores means dropped as the Biology subject performance dropped from rank A up to the least rank E.

Table 4.23 Leven's test for equality of variance for Biology

	F	df1	df2	Sig.
Confidence	1.493	4	249	0.205
Male Domain	0.652	4	249	0.626
Teacher Perception	0.401	4	249	0.808
Usefulness	0.648	4	249	0.629

Table 4.23 indicate that we have homogeneity of between-group variance for all four attitude towards sciences scores (significance > 0.05).

Table 4.24 MANOVA Statistics for Biology

	Value	F	Hypothesis df	Error df	Sig.
Pillai's trace	.128	2.056	16.000	996.000	.008
Wilks' lambda	**.874**	**2.123**	16.000	752.180	**.006**
Hotelling's trace	.143	2.178	16.000	978.000	.005
Roy's largest root	.128	7.941	4.000	249.000	.000

Table 4.24 presents MANOVA statistics. MANOVA analyses confirmed that there was a significant multivariate effect for the combined dependent variables: ә=0.874, F (4,249) = 2.123, P = 0.006 (highlighted in bold in Table 4.24).

Table 4.25 ANOVA Statistics for Biology

Dependent Variable		Sum of Squares	df	Mean Square	F	Sig.
Confidence	Contrast	1627.888	4	406.972	**5.616**	**0.000**
	Error	18044.569	249	72.468		
Male Domain	Contrast	762.868	4	190.717	**3.853**	**0.005**
	Error	12326.096	249	49.502		
Teacher Perception	Contrast	823.735	4	205.934	**2.717**	**0.030**
	Error	18871.147	249	75.788		
Usefulness	Contrast	911.260	4	227.815	**3.280**	**0.012**
	Error	17293.264	249	69.451		

Univariate independent one-way ANOVAs (Table 4.25) showed significant main effects for Biology subject performance in respect of Confidence: F (4,249) = 5.616, P < 0.001, Male domain: F (4,249) = 3.853, P = 0.005, Teacher perception: F (4,249) = 2.717, P = 0.030, and Usefulness: F (4,249) = 3.280, P = 0.012.

Tukey analysis showed that: students Confidence in learning sciences attitude for highest performing students in Biology subject, ranked in quintile A, was significantly different with lowest performing students in Biology subject, ranked in quintile E, (P < 0.001), quintile B (P = 0.04), quintile D (P = 0.08). Stereotype of sciences as a male domain attitude for highest performing students in Biology subject, ranked in quintile A, was significantly different with lowest performing students in Biology subject, ranked in quintile E, (P < 0.002). Studentôs Teacher perception attitude for highest performing students in Biology subject, ranked in quintile A, was significantly different with lowest performing students in Biology subject, ranked in quintile E, (P < 0.020). Perceived usability of sciences attitude for highest performing students in Biology subject, ranked in quintile A, was significantly different with lowest performing students in Biology subject, ranked in quintile E, (P < 0.005).

4.2.6 Attitudes towards Sciences by Performance of the Student in Physics Subject.

Attitudes on confidence in learning sciences, stereotypes of sciences as male domain, teacher attitudes towards a student as a learner of sciences and perceived usability of sciences were measured in five different quintiles of the studentôs average grade in Physics subject.

Studentôs Physics marks for previous three consecutive terms we averaged and five rank quintiles (A = Highest to E = Lowest quintile rank), were generated from the students average marks and each student was assigned his/her respect quintile grade in Physics subject.

Table 4.26 Attitude towards sciences scores by Physics subject

Physics Grade	N	Confidence		Male Domain		Teacher Perception		Usefulness	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
A	49	47.65	7.702	42.92	6.399	44.18	8.072	52.12	6.642
B	51	47.06	8.945	41.78	6.084	42.69	8.758	50.31	8.317
C	53	47.72	7.657	41.30	7.597	43.23	8.892	49.13	7.898
D	48	43.79	8.906	41.67	7.150	42.13	8.809	46.96	8.364
E	53	43.17	9.85	37.51	7.577	41.15	9.516	46.77	9.872

These initial statistics (presented in Table 4.26) *suggest* that the brightest students in Physics subject had the highest scores in three attitudes towards sciences: Male Domain, Teacher Perception and usefulness. Confidence in learning sciences attitude scores mean was relatively similar at a glance, although fourth quintile students (D) had slightly higher scores than other students. All attitude scores means dropped as the Physics subject performance dropped from rank A up to the least rank E, except Confidence in learning sciences attitude.

Table 4.27 Leven's test for equality of variances for Physics subject

	F	df1	df2	Sig.
Confidence	0.530	4	249	0.714
Male Domain	0.572	4	249	0.683
Teacher Perception	0.290	4	249	0.884
Usefulness	2.079	4	249	0.084

Table 4.27 indicate that we have homogeneity of between-group variance for all four attitude towards sciences scores (significance > 0.05).

Table 4.28 MANOVA Statistics for Physics subject

	Value	F	Hypothesis df	Error df	Sig.
Pillai's trace	0.142	2.288	16.000	996.000	0.003
Wilks' lambda	**0.863**	**2.317**	16.000	752.180	**0.002**
Hotelling's trace	0.153	2.330	16.000	978.000	0.002
Roy's largest root	0.102	6.379	4.000	249.000	0.000

MANOVA analyses (Table 4.28) confirmed that there was a significant multivariate effect for the combined dependent variables: ə=0.863, F (4,249) = 2.317, P = 0.002 (highlighted in bold in Table 4.28).

Table 4.29 ANOVA Statistics for Physics subject

Dependent Variable		Sum of Squares	df	Mean Square	F	Sig.
Confidence	Contrast	1002.388	4	250.597	**3.342**	**0.011**
	Error	18670.069	249	74.980		
Male Domain	Contrast	883.582	4	220.895	**4.506**	**0.002**
	Error	12205.383	249	49.018		
Teacher Perception	Contrast	265.229	4	66.307	.850	0.495
	Error	19429.653	249	78.031		
Usefulness	Contrast	1029.003	4	257.251	**3.729**	**0.006**
	Error	17175.521	249	68.978		

Univariate independent one-way ANOVAs (Table 4.29) showed significant main effects for Physics subject performance in respect of Confidence: F (4,249) = 3.342, P = 0.011, Male domain: F (4,249) = 4.506, P = 0.002, and Usefulness: F (4,249) = 3.729, P = 0.006. Teacher attitude towards a student as a learner of sciences attitude was not significant.

Tukey analysis showed that: Stereotype of sciences as a male domain attitude for lowest performing students in Physics subject, ranked in quintile E, were significantly different with quintiles, A (P = 0.001), B (P = 0.018), C (P = 0.045), and D (P = 0.026). Perceived usability of sciences attitude for highest performing students in Physics subject, ranked in quintile A, was significantly different with D (P = 0.020) and E (P < 0.011).

4.2.7 Attitudes towards Sciences by Performance of the Student in Chemistry Subject.

Attitudes on confidence in learning sciences, stereotypes of sciences as male domain, teacher attitudes towards a student as a learner of sciences and perceived usability of sciences were measured in five different quintiles of the studentǿs average grade in Chemistry subject.

Studentǿs Chemistry marks for previous three consecutive terms we averaged and five rank quintiles (A = Highest to E = Lowest quintile rank), were generated from the students average marks and each student was assigned his/her respect quintile grade in Chemistry subject.

Table 4.30 Attitude towards sciences scores for Chemistry subject

Chemistry Grade	N	Confidence		Male Domain		Teacher Perception		Usefulness	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
A	50	49.22	7.327	43.74	6.027	45.26	7.669	51.88	7.325
B	51	46.16	7.078	42.39	7.164	42.16	9.207	49.94	6.562
C	53	46.58	8.441	38.89	7.395	42.92	8.517	49.40	7.970
D	53	43.91	8.930	40.92	7.035	42.74	8.263	46.49	8.147
E	47	43.47	11.051	38.98	7.258	40.06	9.979	47.53	11.196

These initial statistics (presented in Table 4.30 and Figure 7) *suggest* that the brightest students in Chemistry subject had the highest scores in all the four attitudes towards sciences.

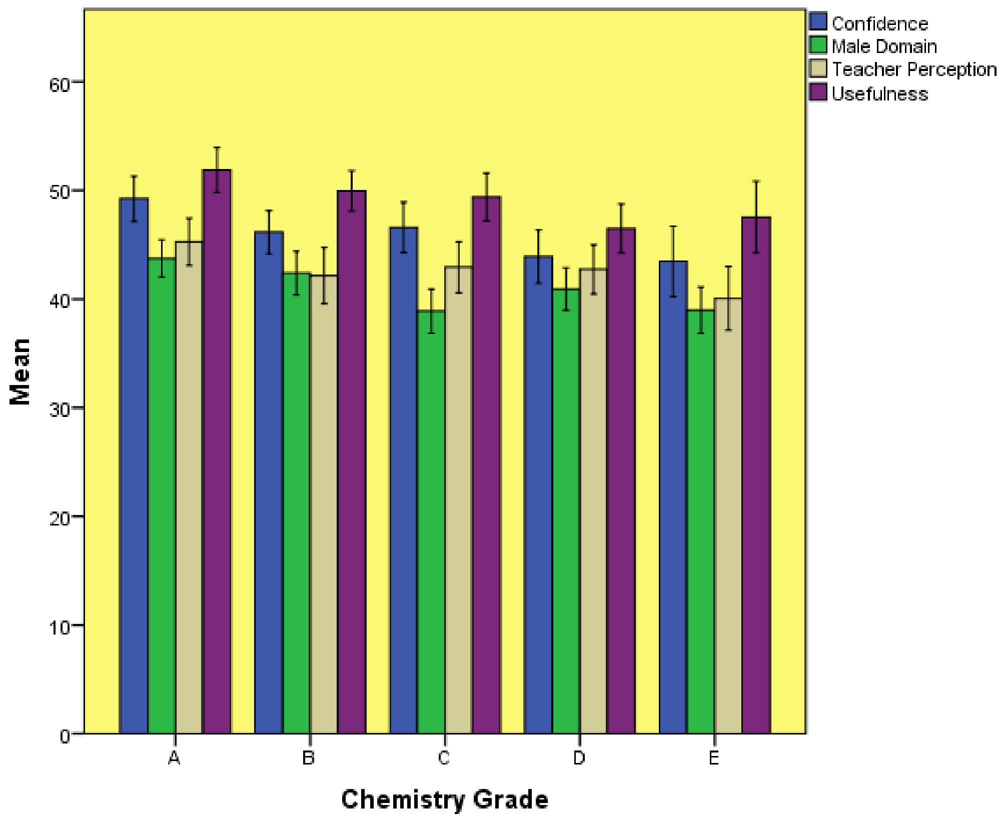

Figure 4.7 Attitude towards sciences scores by Student's Chemistry Subjects Performance.

Table 4.31 Leven's test for equality of variances for Chemistry subject

	F	df1	df2	Sig.
Confidence	3.292	4	249	0.012
Male Domain	.413	4	249	0.799
Teacher Perception	1.068	4	249	0.373
Usefulness	4.189	4	249	0.003

Table 4.31 indicate that we have homogeneity of between-group variance for Male dominance scores and Teacher perception scores (significance >0 .05), but not for Confidence scores and usefulness scores (significance 0<0 .05).

Table 4.32 MANOVA Statistics for Chemistry subject

	Value	F	Hypothesis df	Error df	Sig.
Pillai's trace	0.143	2.306	16.000	996.000	0.002
Wilks' lambda	**0.863**	**2.327**	16.000	752.180	**0.002**
Hotelling's trace	0.153	2.332	16.000	978.000	0.002
Roy's largest root	0.093	5.807	4.000	249.000	0.000

MANOVA analyses (Table 4.32) confirmed that there was a significant multivariate effect for the combined dependent variables: ə=0.863, F (4,249) = 2.327, P = 0.002 (highlighted in bold in Table 4.32).

Table 4.33 ANOVA Statistics for Chemistry subject

Dependent Variable		Sum of Squares	df	Mean Square	F	Sig.
Confidence	Contrast	1068.033	4	267.008	**3.574**	**0.007**
	Error	18604.423	249	74.717		
Male Domain	Contrast	903.190	4	225.798	**4.614**	**0.001**
	Error	12185.774	249	48.939		
Teacher Perception	Contrast	671.708	4	167.927	2.198	0.070
	Error	19023.174	249	76.398		
Usefulness	Contrast	902.793	4	225.698	**3.248**	**0.013**
	Error	17301.730	249	69.485		

Univariate independent one-way ANOVAs (Table 4.33) showed significant main effects for Chemistry subject performance in respect of Confidence: F (4,249) = 3.574, P = 0.007, Male domain: F (4,249) = 4.614, P = 0.001, and Usefulness: F (4,249) = 3.248, P = 0.013. Teacher attitude towards a student as a learner of sciences attitude was not significant.

As we know that we had a problem with the homogeneity of variance for Confidence scores and Usefulness scores across Chemistry subject ranks (Table 4.31), we examined those scores again, using an independent one-way ANOVA with Brown-Forsythe F and Welchȏs F adjustments.

Table 4.34 Unadjusted ANOVA Outcome for Chemistry subject

		Sum of Squares	df	Mean Square	F	Sig.
Confidence	Between Groups	1068.033	4	267.008	3.574	0.007
	Within Groups	18604.423	249	74.717		
	Total	19672.457	253			
Usefulness	Between Groups	902.793	4	225.698	3.248	0.013
	Within Groups	17301.730	249	69.485		
	Total	18204.524	253			

Table 4.34 confirms what we saw in Table 4.32: unadjusted one-way ANOVA outcome, Confidence F (4,249) = 3.574, P = 0.007, Usefulness F (4,249) = 3.248, P = 0.013.

Table 4.35 Adjusted Outcome for homogeneity of variances for Chemistry subject

		Statistic[a]	df1	df2	Sig.
Confidence	Welch	3.669	4	123.141	0.007
	Brown-Forsythe	3.535	4	215.824	0.008
Usefulness	Welch	3.480	4	122.894	0.010
	Brown-Forsythe	3.196	4	204.517	0.014

a. Asymptotically F distributed.

Table 4.35 shows the revised outcome, adjusted by Brown-Forsythe F and Welchős F statistics. There is still a highly significant difference in Confidence attitude across Chemistry subject performance quintiles, Welch: F (4,123.141) = 3.669, P = 0.007, and also Usefulness of sciences attitude across Chemistry subject performance quintiles, Welch: F (4, 215.824) = 3.535, P = 0.008. Thus violation of homogeneity of variance poses no threat to the validity of our results.

Game-Howell *post hoc* tests showed that students Confidence in learning sciences attitude in Chemistry subject performance, student in quintile A was significantly different with students in quintile D (P = 0.011), and E (P = 0.029). Perceived usability of sciences attitude in Chemistry subject students in quintile A was highly significantly different with quintile D group ($P < 0.005$).

Tukey analyses showed that Stereotype of sciences as a male domain attitude in group A was significantly different with group C ($P = 0.005$) and group E ($P = 0.008$).

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Girls perceive science as male domain more than boys and girls have higher attitude on perception usability of science than boys.

School 4, which was girls only high school, had highest scores on all three attitudes which were significant across schools: confidence in learning science, stereotypes of science as male domain and perception on usability of science.

There was no significant difference between forms: 2 and 3 students in attitudes towards sciences.

Students performing best overall (in 1st and 2nd quintile) had highest attitude in Confidence in learning sciences, Stereotypes of science as male domain and perception on usability of science.

Students with highest performance (in 1st quintile) in Biology subject had highest attitude in Confidence in learning sciences, Stereotypes of science as male domain, Teacher attitudes towards a student as a learner of science and perception on usability of science.

Students with highest performance (in 1st quintile) in Physics subject had highest attitude in Confidence in learning sciences, Stereotypes of science as male domain, and perception on usability of science.

Students with highest performance (in 1st quintile) in Chemistry subject had highest attitude in Confidence in learning sciences, Stereotypes of science as male domain, and perception on usability of science.

5.2 Limitations of the study

Although the descriptive survey design employed in the study enabled data collection on seven variables, there were increased chances of sampling errors. Despite the fact that the design allowed for a large number of subjects, the number used was small since more subjects could at tract increased costs. The few public schools in the District and the proportionate sampling technique may not have provided a truly representative sample and since the design was non-experimental, independent variables might not have been fully controlled. The study was limited to public secondary schools in Kamukunji District in Nairobi County.

5.3 Recommendations

I would recommend teachers in all schools to undertake similar study in their schools and have informed evidence when advising students on careers to choice. This will help since students with low attitudes in science can be advices to take careers which do not required science subjects.

Future research studies are recommended to use bigger sample sizes which includes more schools in different geographical location. This will be more accurate for inference of the results to the whole country students.

All the forms (form 1, 2, 3, 4) should be sampled to give a more reliable result

New variables can also be added to help in understanding the impact of attitudes towards sciences.

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Appendix A

Modified Fennema-Sherman Attitude Scales

by Diana Doepken, Ellen Lawsky, and Linda Padwa

In an effort to study students' attitudes towards math, Elizabeth Fennema and Julia A. Sherman constructed the following attitude scale in the early 1970's. The scale consists of four subscales: a confidence scale, a usefulness scale, a scale that measures mathematics as a male domain and a teacher perception scale. Each of these scales consists of 12 items. Six of them measure a positive attitude and six measure a negative attitude.

This scale could give a teacher and individual student useful information about that particular student's attitude(s) towards science.

Science Attitude Scale as Modified from the Fennema-Sherman Attitude Scale

1.	I am sure that I can learn science.	A B C D E
2.	My teachers have been interested in my progress in science.	A B C D E
3.	Knowing science will help me earn a living.	A B C D E
4.	I don't think I could do advanced science.	A B C D E
5.	Science will not be important to me in my life's work.	A B C D E
6.	Males are not naturally better than females in science.	A B C D E
7.	Getting a teacher to take me seriously in science is a problem.	A B C D E
8.	Science is hard for me.	A B C D E
9.	It's hard to believe a female could be a genius in science.	A B C D E
10.	I'll need science for my future work.	A B C D E
11.	When a woman has to solve a science problem, she should ask a man for help.	A B C D E
12.	I am sure of myself when I do science.	A B C D E
13.	I don't expect to use much science when I get out of school.	A B C D E
14.	I would talk to my science teachers about a career which uses math.	A B C D E
15.	Women can do just as well as men in science.	A B C D E
16.	It's hard to get science teachers to respect me.	A B C D E
17.	Science is a worthwhile, necessary subject.	A B C D E
18.	I would have more faith in the answer for a science problem solved by a man than a woman.	A B C D E
19.	I'm not the type to do well in science.	A B C D E
20.	My teachers have encouraged me to study more science.	A B C D E
21.	Taking science is a waste of time.	A B C D E
22.	I have a hard time getting teachers to talk seriously with me about science.	A B C D E
23.	Science has been my worst subject.	A B C D E
24.	Women who enjoy studying science are a little strange.	A B C D E

25. I think I could handle more difficult science. A B C D E
26. My teachers think advanced science will be a waste of time for me. A B C D E
27. I will use science in many ways as an adult. A B C D E
28. Females are as good as males in science. A B C D E
29. I see science as something I won't use very often when I get out of high school. A B C D E
30. I feel that science teachers ignore me when I try to talk about something serious. A B C D E
31. Women certainly are smart enough to do well in science. A B C D E
32. Most subjects I can handle OK, but I just can't do a good job with science. A B C D E
33. I can get good grades in science. A B C D E
34. I'll need a good understanding of science for my future work. A B C D E
35. My teachers want me to take all the science I can. A B C D E
36. I would expect a woman scientist to be a forceful type of person. A B C D E
37. I know I can do well in science. A B C D E
38. Studying science is just as good for women as for men. A B C D E
39. Doing well in science is not important for my future. A B C D E
40. My teachers would not take me seriously if I told them I was interested in a career in science and mathematics. A B C D E
41. I am sure I could do advanced work in science. A B C D E
42. Science is not important for my life. A B C D E
43. I'm no good in science. A B C D E
44. I study science because I know how useful it is. A B C D E
45. Science teachers have made me feel I have the ability to go on in science. A B C D E
46. I would trust a female just as much as I would trust a male to solve important science problems. A B C D E
47. My teachers think I'm the kind of person who could do well in science. A B C D E

Key to Modified Fennema-Sherman Scale for Math and Science

Key:

C = Personal confidence about the subject matter
U = Usefulness of the subject's content
M = Subject is perceived as a male domain
T = Perception of teacher's attitudes
+ = Question reflects positive attitude
- = Question reflects negative attitude

Question #	Category of Question	Attitude
1	C	+
2	T	+
3	U	+
4	C	-
5	U	-
6	M	+
7	T	-
8	C	-
9	M	-
10	U	+
11	M	-
12	C	+
13	U	-
14	T	+
15	M	+
16	T	-
17	U	+
18	M	-
19	C	-
20	T	+
21	U	-
22	T	-
23	C	-
24	M	-
25	C	+
26	T	-
27	U	+
28	M	+
29	U	-
30	T	-

31	M	+
32	C	-
33	C	+
34	U	+
35	T	+
36	M	-
37	C	+
38	M	+
39	U	-
40	T	-
41	C	+
42	U	-
43	C	-
44	U	+
45	T	+
46	M	+
47	T	+

Scoring Directions:

Each positive item receives the score based on points

A = 5 B = 4 C = 3 D = 2 E = 1

The scoring for each negative item should be reversed

A = 1 B = 2 C = 3 D = 4 E = 5

Add the scores for each group, T, C, U, M, to get a total for that attitude.
The highest possible score for each group of statements is 60 points.