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The Relationship between Students' Attitude towards Mathematics and their Mathematics Self-Concept and Achievement in the Military Science Programme of Egerton University, Kenya

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Abstract
Knowledge of mathematics as a tool for use in everyday life is important for the existence of any individual and society. It is for this reason that tertiary institutions take mathematics as part of professional development. Despite the importance of mathematics as a basic preparation for full participation as a functional member of the society, the performance in the subject has been poor as shown in national examinations in Kenya. The general trend in students' performance in mathematics in the military science programme of Egerton University indicates higher percentage of graduates who underachieve in the subject. This study sought to investigate the relationship between Students' attitude towards mathematics and their mathematics self-concept and achievement in the military science programme offered at Egerton University in Kenya. The guiding theory was based on the Systems Approach theory. Correlation research design was used in the study. The study population was 145 student officers (Cadets) enrolled in the military science programme of Egerton University in Kenya. Sample size for the study was the entire population. Two instruments were used namely: Self Descriptive Questionnaire III (SDQ III) and Students' Mathematics Attitude Scale (SMATS). These instruments were validated and pilot tested for suitability and reliability. The study found the reliability for Students' Mathematics Self Concept (SMSC) and SMATS to be 0.86 and 0.82 respectively using Cronbach's alpha, hence were reliable. Questionnaires solicited information on the students' academic background and their mathematics scores in KCSE. Students' Mathematics Achievement Scores (SMAS) were mathematics scores in University examinations. Data was analyzed using descriptive and inferential statistics to test the stated hypotheses at alpha (α) level of 0.05. Pearson moment correlation was used to test hypotheses. Statistical Package for Social Sciences (SPSS) was used for data analysis. This study is important to understand factors that affect students' attitude towards mathematics and their mathematics self concept and achievement in order to embrace mathematics as a utility subject in school and life
Keywords: Mathematics, Self Concept, Attitude, Achievement, Tertiary institutions, Kenya

1.0 Background Information

Mathematics is an indispensable tool in the development of science and technology in the sense that formulation, computing, calculation, evaluation among others are the important methodologies applied in them (Cockcroft, 1982; Saitoti, 2000). Advances in science and technology improve the quality of life of mankind. Mathematics equips students with uniquely powerful set of tools to understand and change the world.

Mathematics is an essential subject in military science. Roman and Modern warfare have been characterized by the rationality of goals and means; quantization of troops, inventory, distances, order of battle; and discipline and shared goals of fighting troops, commanders and the hinterland (Bernhelm & Booss, 2001).

Today, most military historians agree that the rise of modern war in the period 1500-1945 was accompanied by a rise in mathematics based technologies and other innovations, but not driven by it (Machiavelli, 1990). The new ways of warfare came from the mathematical idea. Discarding differences and emotions between adversaries, the basic assumption of modern warfare is that both sides are guided by the same kind of logic, rationality, and reason which is embedded in mathematics learning.

As documented in Booss, Bernhelm, and Hoyrup (1984), Babylonian clay tablets from about 1800 B.C dealt with siege computation. These included the number of bricks needed for siege ramps, the volume of earth to be dug and how much workforce was required. The same calculations were used when building a temple or digging an irrigation canal. Many real-world mathematical problems on the thousands of preserved tablets show, for instance in the choice of unknowns for the quadratic equations, that they were meant to puzzle and train the student in preparation for the solution of problems in real situations.

The Renaissance had a high appreciation of the possibilities of mathematics in every practice. Specific military needs (cartography, artillery and ballistics) partly preceded, partly met specific civilian needs like the theory of the central perspective, bookkeeping, merchants' calculation and algebra (Booss et al, 1984). Keeping it a strict military secret, the fifteenth-century Portuguese court took up a systematic development of navigational

mathematics which led them to distinguish between great circle arcs (geodetic curves) and loxodromes (curves of constant angles like the parallels). As cited in Booss et al, when Niccolo Tartaglia tried to give rules for the art of the bombardier Nova Scientia, he abandoned Aristotle's concept of a piecewise linear trajectory and created the modern concept of a function f(x) that produces a smooth curve. The Flemish mathematician Simon Stevin later quartermaster general of the army under Maurice of Nassau, engineered a system of sluices to flood certain areas in defence of besieged cities and thus founded the modern statics and hydrostatics (Booss et al, 1984).

Despite the importance that mathematics play in progress towards attaining the stated educational goals, many studies have shown poor performances in the subject (Ogunniyi, 1996).

Most courses offered at tertiary and university institutions require students to have passed at certain minimum grade level in mathematics at KCSE in addition to other subjects. Even non mathematical courses require the usage of mathematics at certain stages. Thus mathematics is regarded as essential due to the type of skills and knowledge that learners acquire. Performance in mathematics is a critical tool of selection of students into science courses at universities and into science related careers (Burton, 1996; Eshiwani, 1984; Fennema, 1990).

Tertiary institutions and mainly the middle level colleges are consumers of the bulk of secondary school leavers who enroll for various courses in preparation for the world of work. According to Cockcroft (1982) and Githua (2002) the knowledge of mathematics as a tool for use in everyday life is important for the existence of any individual and society. Researchers have interest in the conceptualization, assessment and investigation of students' mathematics self concept and their perceptions of the subject at all levels of education.

The objectives of the military science programme are to develop military officers to perform professional duties, plan, and design and implement innovative military projects and services using available resources effectively and efficiently. It also aims to develop officers who will evaluate and analyse different situations and make rational decisions, and adjust to different working environments and mobilize resources for maximum best use for the Kenyan Society.

Mathematics is one of the subjects taught to realize the objectives in the MS programme. The performance of military students in mathematics in the MS programme has been relatively poor with a high number underachieving with grade D as shown in Table 1.

Table 1: Candidates Overall Performance in Mathematics for Three Intakes by Grade in the MS of Egerton University.

Year/ Grades	A	B	C	D	Totals
2004	22 (15.83%)	26 (18.71%)	34 (24.46%)	57 (41.00%)	139
2005	25 (17.36%)	29 (20.14%)	29 (20.14%)	61 (42.36%)	144
2006	33 (22.76%)	32 (22.07)	31 (21.38)	49 (33.79)	145

Source: School of Continuing Education, Egerton University (2006).

The inclusion of mathematics in the MS is not a new phenomenon. Mathematics has played a substantive role in the development of warfare since the ancient times. The mathematics courses are aimed at giving students the opportunity to acquire a sound mathematical foundation and to develop powers of applying mathematics concepts and procedures and an analytical problem-solving approach.

Academic achievement is a measure of what is learnt and is a major goal in education (Gall, Gall & Borg, 2003). Tables 1 indicate that a high percentage of students underachieve in the subject. The low student achievement in mathematics may be due to negative attitude, lack of motivation to learn mathematics and the students' mathematics self concept among others. Attitudes are learned predispositions to respond positively or negatively to certain objects, situations, institutions, concepts, or other persons (Aiken, 1982). Negative attitudes play a prominent role in the determination of thoughts, memory, learning process and behaviour (Mondoh, 1994). There is a general belief that positive attitudes and in particular the liking for mathematics leads to greater effort that leads to higher achievement (Costello, 1991).

Self-concept is the organization of the perception that the individuals have of themselves and is important in affecting behaviour (Dembo, 1994). Students' mathematics self concept refers to ones' perceived personal mathematical skill, ability, mathematical reasoning ability, enjoyment interest in mathematics (Marsh, 1990c). The students need to have a positive self-concept. Studies that have been conducted in the western world have found a link between self-concept, motivation and achievement in mathematics (Schunk & Pajares, 2000; Watt, 2001). Marsh (1990c) found that mathematics achievement is highly correlated to mathematics self concept.

The poor performance in mathematics has been attributed to many factors within and outside learning institutions. They include learning environment and resources, teaching methodology, attitudes, motivation and society's value system among others (Mondoh, 1994; Githua, 2002; Ngeno, 2004).

1.1 Purpose of the Study

The purpose of the study was to establish the relationship between students' attitude towards mathematics and their mathematics self-concept and achievement in the military science programme offered at Egerton University in Kenya.

1.2 Objectives of the Study

The following objectives guided the study:

i. To establish the relationship between students' attitude towards mathematics and their mathematics self-concept in the MS programme offered by Egerton University.
ii. To establish the relationship between students' attitude towards mathematics and achievement in the subject in the MS programme.

1.3 Hypotheses of the Study

The following null hypotheses were addressed and tested at 0.05 alpha (α) level:

H_o1: There is no statistically significant relationship between students' attitude towards mathematics and their mathematics self-concept in the MS programme of Egerton University.

H_o2: There is no statistically significant relationship between students' attitude towards mathematics and achievement in the MS programme.

1.4 Research Design

The study used correlation research design to explore relationships between variables. Correlation research design refers to studies whose purpose is to discover relationships between variables through the use of correlation statistics. The design allows analysis of the relationships among a large number of variables in a single study. It also provides information concerning the degree of the relationship between the variables being studied and expressed as a correlation coefficient (r) (Gall, Gall & Borg, 2003; Cohen & Manion, 1994; Kathuri & Pals, 1993). The interrelationship of the variables warranted a correlation research design to analyse several variables and explain how they affected the pattern of behaviour in the study (Gall, Gall & Borg, 2003). The research design focused on the military officers whose entry into the profession considers only the mean grade of KCSE performance and does not consider the diversity in terms of their strength in sciences.

1.4.1 Sampling Procedure and Sample Size

The students pursuing military science programme were used as the sample. The general rule is to use the largest sample possible because the main interest is learning about a population from which a sample is drawn (Kathuri & Pals, 1993). Frankel and Wallen (2000) recommend a minimum sample of 100 subjects while Kathuri and Pals (1993) recommend a sample of 103 from a population of 145 for survey research for statistical analysis. For the purpose of this study, the whole population of 145 registered student officers was taken for the study.

1.4.2 Data Collection Instrument

Questionnaires were used to collect data from the student officers. All the questions/statements in the instruments were scored on a non negative 5-point Likert type scale based on the extent to which the respondents agree with the statements.

The questionnaire was adapted from Marsh's Self Descriptive Questionnaire III (SDQ III) of 1992. The SDQ III is designed to measure multiple dimensions of self-concept for college students and adults. It comprises a multidimensional structure rooted in Shavelson et al. (1976) theoretical model of self-concept. The SDQ III is designed to measure self-concepts related to eight non academic and four academic areas and a single global perception of self. This study used the part that measures students' mathematics self concept. This part has 10 statements. The tool uses an eight-point response scale ranging from: Definitely False; False; More False than True; More True than False; Mostly True; True; Definitely True. In this study the responses were modified to a 5-point Likert type scale based on the extent to which they agree with the statement.

The Students' Mathematics Attitude Scale (SMATS), adapted from Aiken (1982), which is constructed

by Likert's method of summated ratings, was used to determine the direction and the intensity of their attitude in mathematics. The questionnaire consists of 24 statements. Each of the statement expresses a feeling or attitude toward mathematics.

1.5 Results and Discussion

1.5.1 Relationship between Students' Attitude towards Mathematics and their Mathematics Self Concept.

Hypothesis one (H_o1) of the study sought to find out whether there is a statistically significant relationship between students' attitude towards mathematics and their mathematics self concept in the military science programme of Egerton University. The relationship between the two constructs was obtained by running a bivariate correlation. In this study, students' attitude towards mathematics was constitutively defined as the mental view, opinions and behaviour towards a certain aspects or occurrence. The students responded to 24 statements (items) that expressed a feeling or attitude towards mathematics. Out of 140 students who filled in the questionnaire, 139 responded to all the 24 items on the scale measuring their attitude towards mathematics. The overall mean and standard deviation for the 24 items used to measure attitude is summarized in Table 2.

In this study the students' mathematics self concept was taken to mean one's perceived personal mathematics skills, ability, mathematical reasoning, enjoyment and interest in mathematics as defined by Marsh (1990b). The students responded to ten statements (items) that measured the construct on a 1–5 point Likert type scale based on the extent to which they agree with the statement. That is Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly Agree (SA). Negative statements were scored in a reverse order. The overall mean and standard deviation for the ten items used to measure students mathematics self concept is summarized in Table 2.

Table 2: Summary of Means and Standard Deviations for the items measuring Mathematics Self Concept and Attitude in Students.

Variable	N	Mean	SD
SMSC	138	3.98	.69
SMATS	139	4.01	.56

The results in Table 2 show the overall mean and standard deviation of 3.98 and 0.69 respectively for students' mathematics self concept (SMSC) and 4.01 and 0.56 respectively for students' attitude towards mathematics (SMATS) against a maximum possible score of 5.

A bivariate correlation was run to establish whether the relationship was statistically significant between students' attitude towards mathematics (SMATS) and their mathematics self concept (SMSC) in the MS programme of Egerton University. This gave a correlation coefficient (r) which represents the degree of association between the two variables. The results are summarized in Table 3.

Table 3: Pearson Correlation between Students' Attitude towards Mathematics and their Mathematics Self Concept (N = 138)

Variable	SMSC	SMATS	N
SMSC	1	0.702*	138
SMATS	0.702*	1	139

* Correlation is significant at Alpha (α) = 0.05 level (two tailed).

The relationship is statistically significant at 0.05 Alpha (α) level in a two tailed test.

The results show that there is a strong positive relationship between students' self-concept and students' attitudes towards mathematics. The Pearson product moment correlation coefficient is 0.702 and is statistically significant at 0.05 α level. The null hypothesis (H_o1) that states that there is no statistically significant relationship between students attitude towards mathematics and their mathematics self concept was therefore rejected.

The findings of the study revealed that the relationship between students' attitude towards mathematics and their mathematics self-concept was strong and statistically significant at 0.05 Alpha (α) level with a correlation coefficient (r) of 0.702. The findings of the study also show high mean scores of 4.01 (80.27%) and 3.93 (79.57%) for the students' attitude towards mathematics (SMATS) and their mathematics self concept (SMSC) respectively. This indicates that the students pursuing the military science course have positive attitude towards mathematics and a positive mathematics self concept.

The strong positive relationship between the two constructs agrees with Travers (1982) and Milne (1992). Travers held that students with a positive self concept has energizing effect on behaviour while Milne's findings showed that motivation, attitude to success and perceived usefulness of mathematics were high for mature age students throughout the course of study in Victoria, Australia. Travers (1982) argued that a positive self concept has an energizing effect on behaviour and results in vigorous pursuits of goals that individuals believe are worthwhile and should be used to enhance students mathematics self concept. These results are also consistent with the findings of a study in Iran which showed that the relationship between the index of mathematics self concept and mathematics achievement for Iranian students was positive and significant (Kiamanesh & Kheirieh, 2001). The positive relationship between the constructs could be attributed to the prospect of securing employment and the privilege of serving in the military as a commissioned officer on successful completion of the course.

1.6.2 Relationship between students' attitude towards mathematics and achievement in the MS programme.

Hypothesis two (H_o2) of the study sought to find out whether there is a statistically significant relationship between students' attitude towards mathematics and their achievement in the MS programme. In this study the achievement were students' final scores in their mathematics course in the University examinations. The means and standard deviations of students' attitude towards mathematics (SMATS) and their achievement in mathematics (SMAS) are summarized in Table 4.

Table 4: Summary of Means and Standard Deviations for the items measuring Students' Attitude towards Mathematics and their Achievement.

Variable	N	Mean	SD
SMATS	139	4.01	.56
SMAS	140	3.84	1.20

To establish whether the relationship was statistically significant between students' attitude towards mathematics and their achievement in mathematics in the MS programme a bivariate correlation was run. The results are summarised in Table 5.

Table 5: Pearson Correlation between Students' Attitude towards Mathematics and their Achievement (N = 139)

Variable	SMATS	SMAS	N
SMATS	1	0.467*	139
SMAS	0.467*	1	140

* Correlation is significant at Alpha (α) = 0.05 level.

The results show a positive relationship between the two constructs with a correlation coefficient (r) of 0.467. The correlation is significant at 0.05 Alpha (α) level in a 2-tailed test. The null hypothesis (H_o2) that states that there is no statistically significant relationship between students' attitude towards mathematics and their achievement in the MS programme was therefore rejected.

The results of the study show mean scores of 4.01 and 3.84 out of a possible score of 5 in students' attitude towards mathematics (SMATS) and their achievement (SMAS) respectively. The results also indicate a positive relationship with a correlation coefficient (r) of 0.354. The relationship is statistically significant at 0.05 Alpha (**α**) level.

The results agree with Milne's (1992) research results in Australia which showed that attitude to success and perceived usefulness of mathematics were high for students throughout the course of study. A study in Iran indicated that students who have positive perceptions or attitudes towards mathematics showed better achievement in both mathematics and science (Kiamanesh, 1997). Other findings show that there is a positive correlation between attitude and achievement though neither attitude nor achievement is dependent on the other but rather interact which each other in a complex and unpredictable ways (Dossey, Mullis, Lindquist & Chamber, 1988). The positive attitude in mathematics in this study, probably driven by the desire to secure employment and serve as an officer in the military, could lead to greater effort and in turn higher achievement as is manifested by the results.

1.7 Conclusions

On the basis of the findings of the study, the following conclusions related to the hypotheses of the study were generalized to the learners of mathematics in the military and post secondary school institutions.

i. Students' attitude towards mathematics affects their self-concept towards the subject.
ii. Students' attitudes towards mathematics affects their achievement in the subject

1.8 Implications of the Study

The results of the study indicate that military science students have positive attitude towards mathematics. Their attitude towards mathematics is positive with a corresponding positive mathematics self-concept. The positive attitude towards mathematics and their self-concept in mathematics suggest that students in tertiary institutions have an intrinsic drive to succeed in the mathematics courses they take despite the diverse interest and liking mathematics. As indicated, mathematics is one of the subjects studied in the military science course. The findings suggest that students in tertiary institutions, irrespective of their background performance, interest and liking of mathematics have the potential to develop favourable attitudes and self esteem towards the subject. Tertiary institutions should therefore exploit the positive change in order to improve the general performance in mathematics. Travers (1982) held that students with a positive self concept have energizing effect on behaviour and results in vigorous pursuits of goals that individuals believe are worthwhile and should be used to enhance students mathematics self concept.

The results of the study have also shown that students' attitude towards mathematics and achievement in the subject are positively related. This implies that a favourable attitude towards mathematics among students in post secondary school institutions is possible to be enhanced in order to improve on their achievement in mathematics.

1.9 Recommendations

The positive relationship between students' attitude towards mathematics and their achievement should be exploited and used to improve the general performance as well as to enhance the students' self concept in the subject. Tertiary institutions and in particular universities should use the opportunity to popularize mathematics education in linking its usefulness to life. Some of the university students may have developed positive attitude towards mathematics because it was part of the course one pursued. These are the people who could be used to promote the performance of the subject in schools which has been reported to underachieve in past examinations (KNEC, 2006).

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