UNIVERSITY OF CAPE COAST

ATTITUDES OF FEMALE PARTICIPANTS AND NON-PARTICIPANTS OF SCIENCE TECHNOLOGY AND MATHEMATICS EDUCATION CLINICS TOWARDS SCIENCE AND MATHEMATICS

BY

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2009

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere.

Candidate's Signature:…………………......... ………… Date:………………

Name of Candidate: Bukari Abdulai

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines of supervision of thesis laid down by the University of Cape Coast

Principal Supervisor's Signature…………………………….. Date………………

Name: Prof. Joseph Ghartey Ampiah

Co-Supervisor's Signature…………………………………… Date:……………..

Name: Dr. Fiifi Mensah

ABSTRACT

This study investigated the attitudes of girls towards science and mathematics. Two categories of girls were involved in the study, thus those who attended the STME clinic in 2004 and those who did not attend the clinic. The simple random sampling technique was employed to select a total of 223 girls from 34 JSS in the Bawku East Municipality, Bawku West and Garu-Tempane Districts. The average age of the girls was 16.4 years with a standard deviation of 1.7.

Three instruments were used to collect data for the study. These included the Mathematics Attitude Scale Instrument (MASI), the Science Attitude Scale Instrument (SASI) and an Interview guide. Reliability was achieved for the attitude scales using the Crombach's alpha. Alpha levels of 0.85 and 0.91 were obtained for the MASI and SASI respectively. All three instruments were validated through expert judgment. Data from the attitude scales were analysed using a t-test, while data collected using the interview guide were analysed qualitatively.

There was a significant difference in attitude towards science for STME girls (M = 114.34, SD = 13.78) and NSTME girls [M = 102.83, SD = 14.41; t (221) = 6.07, p = .001]. There was also a significant difference in attitude towards mathematics for STME girls (M = 110.55, SD = 14.13), and non-STME girls [M = 102.23, SD = 14.90; t (221) = 4.26, p =.001]. A major recommendation was that the STME clinic should be expanded to cover all girls instead of just a selected few.

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I will not forget to thank all authors whose works have either been cited directly or have in one way or the other helped this work to become successful.

DEDICATION

I dedicate this work to my parents, the late Mr. Abodiba Bukari and Mrs. Abodiba Habiba Ageeba who made sure I became what I am today.

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CHAPTER ONE

INTRODUCTION

Background to the Study

In today's world, basic comprehension of mathematical and scientific knowledge and technological skills has become very important for both personal and national development. Science, Technology and Mathematics (STM) have become an integral part of the world's culture and any country that overlooks these areas of knowledge only does so at the expense of its development.

Whereas science involves knowledge of natural phenomena, technology is concerned with doing and getting things done in easier, better, faster or in more efficient ways (UNESCO, as cited in Ghana Education Service [GES], 1998). Science and Technology permeate almost every aspect of our lives. Knowledge in science and its application has greatly contributed to the rapid modernisation of the world. Low level of mathematical and scientific knowledge among the human resource base of a country is usually marked by under-development, lack of progress, inability to harness and utilise physical resources and inability to develop talents and benefit from it.

The human resource base of every nation is made up of both males and females. It is, therefore, very important for both sexes to be well grounded in science, technology and mathematics. Over the years, society has come to assign roles to males and females. Whereas sex roles are natural and are not changeable, gender roles on the other hand are imposed by societies and may differ from one society to the other. What is known to be done by men in one country may not necessarily be what men do in another country. Gender roles are therefore changeable and either sex can assume different roles depending on the society in which one finds one's self. Unfortunately however, in most societies, gender roles have come to be firmly linked to the sexes, thus resulting in gender stereotyping. The roles ascribed to girls by society in general, discriminate against girls in the area of STM (Kelly, 1981). This makes girls think of science and mathematics as a preserve for boys, thus giving rise to gender differences in participation and achievement in STM (Association of American University Women [AAUW], 1992).

Referring to the case of Africa, Ndunda (1999) described as distressing the low level of female participation in science and mathematics related programmes in African Universities. Ndunda used statistics contained in a five year development plan in the University of Namibia to illustrate his assertion. The statistics indicated that out of a total of 105 students in the Faculty of Science in 1992, 73 (69%) were males with 32 (31%) being females. With a total of 124 students in the Faculty of Science in 1993, 80 (64.5%) were males and 44 (35.5%) were females. In 1994, there were 149 students in all in the Faculty of Science out of which 103 (69%) were males whilst 46 (31%) were females. Though these figures indicate slight annual increases in the enrolment of girls in the faculty, Ndunda further argued that this is nevertheless accompanied by an alarming drop out rate. He used a cohort of 200 students from the Faculty of Science in the University of Namibia to illustrate his point. This cohort had reduced to only 53 by the end of the second year and by the end of the third year, they were only 28 students. Ndunda thinks that the low participation of females in the science related programmes in the universities is a carry-over from secondary schools. He concludes that the impact of the low participation of girls in studying science courses in secondary schools and the universities is reflected in very few women in significant science-based careers such as engineering, medicine, computer science and technology.

The situation is not different in Ghana. One of the three secondary schools offering the science programme in the Bawku East District in which this study was carried out, has never registered 5% of its total female students into the science programme from 1997 to 2004. For example, statistics available in the school indicates that in 2000, only 9 out of 136 girls enrolled for the science programme. The statistics also showed that 4 out of 129 girls enrolled for the science programme in 2002, 2 out of 138 in 2003, and 6 out of 129 girls enrolled for science in 2004. A similar trend exists in the only secondary school offering the science programme in the other district (Bawku West District) where this study was carried out. Records in the school shows that 4 out of 14 girls enrolled for the science programme in 2000 and only 2 out of 27 girls enrolled for science in 2004.

Several factors contribute to gender differences in participation and achievement in science and mathematics. Beliefs about science and mathematics was found to be an important factor among secondary school girls in Conecticut in their decision not to take advance courses or pursue such subjects as careers (Lantz as cited in Chipman, S., Brush, L., & Wilson, D., 1984). Lantz found that girls have a proven ability in science and mathematics, but that these subjects are stereotyped “masculine”. This stereotypical attitude, according to Lantz, is operating to discourage secondary school girls from pursuing science and mathematics careers. Fennema & Shereman (1977) also observed that girls tend to consider mathematics as being consistent with a male self-image and inconsistent with a female self-image. A similar view is shared by Sherman (1982) who also observed that a considerable proportion of girls in the secondary school “play dumb” in their mathematics classes because, to them, mathematics is inconsistent with their self-concept. In fact, a very important point has also been raised by Silverman and Pritchard (1994) who think that secondary school girls are uninformed about economic realities and the world of work. To Silverman and Pritchard, girls lack basic information about careers including promotion prospects and the amount of education and training needed to pursue different occupations. While it can be argued that both boys and girls may lack such information, for girls it is combined with stereotypes about science, technology and mathematics as belonging to males.

In a research conducted in Junior Secondary Schools within the West Mamprusi district of the Northern Region of Ghana (Teachers of West Mamprusi District, 2001), it was found that girls tend to suffer from low self-esteem more commonly than boys do. Findings of the study further indicated that the low self-esteem among girls could be attributed to social attitudes, which influence the way people think. Odukoya, cited in Teachers of West Mamprusi District (2001), found in another study among JSS students in Northern Ghana, that both boys and girls have negative attitudes regarding the capabilities of girls particularly in science and mathematics. Nearly 48% of the JSS students who participated in the study agreed that girls are weaker than boys and less likely to succeed, even in school work. Some girls were quick to conclude that they cannot become doctors because to them science is very difficult. In a similar study of JSS students carried out in the Northern part of Ghana by the Girls' Education Unit (GEU), Mackinnon (2000) reports of general negative attitudes of boys towards girls. JSS teachers who took part in the study reported that girls do not show confidence in their own abilities and are always reluctant to answer questions in pre-technical skills and General Science. The teachers also added that girls mostly relied on boys' answers though their own answers were usually correct.

Most of the factors that contribute to the low participation and achievement of girls in science and mathematics revolve around societal stereotypes which prevent girls from developing positive attitudes towards these disciplines. Some gender activists have however described these societal practices as very discriminatory against girls and women in general. Plato cited in Leder (1992) has argued that males and females should be educated in the same way for effective career preparation. According to Plato

> There is no function in society which is peculiar to woman as woman or man as man; natural abilities are similarly

> distributed in each sex, and it is natural for women to share all occupations with men, though in all, women will be the weaker partners. (p 295)

Plato’s position, at least on this issue, was later supported by Defoe. Defoe, cited in Hoon (2004) has expressed his anger at society's attitude towards the education of women. He describes any practice that denies women the opportunities of learning as the most barbarous customs in the world, adding that if knowledge and understanding had been useless additions to the sex, God Almighty would never have given them.

There is every cause to lament the gender differences in mathematics and science achievement and participation. Aside the fact that mathematics and science have become critical filters at almost every level of education and that those who opt out of these disciplines will be denied important educational opportunities, the cycle of gender inequality in mathematics and science may probably be perpetuated by efforts which rather seek to deal with the problem (Ernest, 1994). Linn (1990) maintains that Advocacies and programmes to address gender differences in mathematics and science can reinforce gender stereotyping and negatively influence many girls' perceptions of mathematics and science, and their own abilities in these disciplines. According to Linn (1990), a situation is also created where male students retain the perception that mathematics and science are male domains. In spite of these skeptical opinions about the adverse effects of gender advocacy and programmes, a number of policies, strategies and legislations have been put in place in different countries by the ministries of education, governments, donor agencies, and Non-Governmental Organizations (NGOs) to ensure that the disadvantaged situation of girls in science and technology is addressed (FAWE, 2003). To achieve gender balance in Zambia for example, a national policy on education that allows girls to choose any technical training programme was introduced in 1984. The Zambian Ministry of Education policy document has a section dealing with gender issues in education, which addresses the problem of inadequate access to education, low achievement and low participation of girls in Mathematics, Science and Technology. According to FAWE (2003), activities undertaken in Zambia under the Ministry of Education project with support from some NGOs in order to improve upon the participation of girls in Mathematics and Science at pre-tertiary institutions have affected the social attitudes of students, parents and others towards Science, Technology and Vocational Education (STVE).

Other African countries such as South Africa, Tanzania and Zimbabwe have initiated similar policies and programmes to address gender disparities particularly in science and technology. The South African government's White Paper on Education highlights the need for addressing issues of gender inequality. Special reference is made of the need to have more females involved in science and technology. In Tanzania, the Policy on Women in Development identifies problems arising from planning without gender focus. Its education policy has expressed a strong commitment for the participation of women in development in science. Zimbabwe has re-appraised its national science curriculum known as the ZIMSCI curriculum. Affordable science kits developed within this framework, using materials readily available in the local environment, have popularized science education particularly in rural areas (FAWE, 2003).

In Ghana, both past governments and the current government have recognised the need to address the lack of gender equity in the participation and achievement of girls in education in general and in science, technology and mathematics in particular. The introduction of the Educational Reforms in 1987 targeted equitable female and male participation in education in general at all levels of education and the abolition of gender-streamed curriculum at the basic level of education. Gender-sensitive teaching and learning materials were also produced (GES, cited in Teachers of West Mamprusi District, 2001). To address the specific problem of low female participation in the sciences, the GES introduced the Science, Technology and Mathematics Education (STME) Clinic to promote the interest of girls in science and science related disciplines. During the clinics, girls are offered the opportunity to engage in hands-on-activities in the areas of science, technology and mathematics to give them experience and facilitate understanding, and hence help them to develop confidence in handling scientific, mathematical and technological subjects and materials.

Statement of the Problem

Long before Ghana embarked on its educational reform in 1987 to give equal access to education for all school children, the Commonwealth Schools Commission issued "Girls, School and Society", a report in 1972 which officially acknowledged the existence of sexism and its negative influences upon the education of girls in Australia and other parts of the world. One aspect of sexism was demonstrated in the mathematics and science education of girls, who were only nominally represented in higher-level mathematics and science classes at secondary schools and in mathematics and science-dependent occupations (Johnston, 1990; Willis, 1989).

Upon realization that society had generally grown to develop some negative attitudes, perceptions and misconceptions about girls' participation in science, technology and mathematics (STM), the Ghana Education Service (GES) instituted the Science, Technology and Mathematics Education (STME) Clinics in 1987 for girls. This was in recognition of the fact that the role of science and technology in the contemporary world was becoming increasingly important and indispensable for both individual and national development. It was also in recognition of the fact that the attitudes and misconceptions carried by society were also influencing girls to develop negative attitudes towards STM.

Despite the efforts by the GES at empowering girls through the STME clinics to take to sciences and mathematics and to develop general positive attitude towards science and mathematics, the number of girls in science and mathematics programmes appear to be woefully inadequate, though there have been claims by the Girls Education Unit and other stake holders that suggest otherwise. One therefore wonders whether the STME clinics have brought any differences in the attitude of female students who participated in the clinics and those who did not.

Purpose of the Study

This study investigated the attitudes of STME and non-STME JSS3 girls towards the disciplines of Science and Mathematics. This became necessary in view of assertions made over the years by leading personalities and organizations regarding the impact of the STME Clinic since its introduction. The purpose of the study was therefore to:

1. determine the differences if any, that exist in the choice of future career among STME and non-STME JSS3 girls
2. find out the pattern in the choice of preferred programme of study among STME and non-STME JSS3 girls
3. find out the reasons for which STME and non-STME JSS3 girls choose to pursue the Science programme at the Senior Secondary School level.
4. find out if there is any significant difference between the attitude of STME and non STME JSS 3 girls towards science and mathematics

Research Questions and Hypothesis

The following research questions and hypotheses guided the study:

1. Do STME and non-STME JSS3 girls differ in their choice of preferred programme of study for SSS and future career?
2. What reasons do STME and non-STME JSS3 girls have for choosing to pursue a general science programme at the SSS level?
3. There is no significant difference between the attitude of STME and non-STME JSS3 girls towards science.
4. There is no significant difference between the attitude of STME and

non-STME JSS3 girls towards mathematics.

Significance of the Study

The Ministry of Education, Science and Sports (MoESS) and the GES are committed to ensuring gender equity at all levels of education. The institution of the STME programme was one of the numerous strategies put in place to address gender imbalances in the education system. The findings of this study will therefore serve as valuable information to the GES about the effectiveness of the programme to address the attitude of girls towards science and mathematics.

The findings of this study will be relevant to teachers since they will be informed about how girls feel about science and mathematics. This will guide them on how to plan their lessons in these subjects to get girls more involved in their lessons.

Findings of this study will be important to both local and international institutions that have demonstrated commitment in the success of the STME through their continued support of the programme.

Finally, the study will add to existing knowledge on the attitudes of female students towards science and mathematics and generate interest in further research.

Delimitation of the Study

At the time of the study, there were a total of 53 JSS Schools in the three Districts in which the study was carried out. The study was confined to only 34 schools whose girls participated in the 2004 STME Clinic session, as the population of interest. Students who were in JSS 1 in 2004 were in their third year in 2006, hence only girls in JSS3 participated in this study since this group had attended the STME clinic three years earlier and therefore were better placed in terms of the development of attitudes towards science technology and mathematics (STM) than first and second year girls.

Limitations

The study did not employ a large sample size. This affected the generalization of the findings of the study.

CHAPTER TWO

REVIEW OF LITERATURE

This chapter reviews literature related to the topic of the study. The review is organized under the following headings:

- The nature and characteristics of attitude
- Attitude formation and change
- Measurement of attitude
- Gender related attitudes in Science, Technology and Mathematics (STM)
- Choice of Academic Programme and Vocational Career among Female Students and Women
- Effects of Science, Technology and Mathematics (STM) Intervention Programmes on the Attitudes of Participants
- The Science, Technology and Mathematics Education (STME) Clinics
- Choice of Academic Programme and Vocational Career among Female Students and Women

The Nature and Characteristics of Attitude

Many researchers have become so interested in the concept of attitude. To professionals such as teachers for instance, the concept of attitude is a major concern because education is all about the development of desirable attitudes towards the use of instructional resources.

Attitude can be regarded as the description of how people typically feel about or react to other people, places, events, things or ideas (Borich & Kubiszyn 1987). Rokeach (1972) contended that an attitude is an organisation of several beliefs focused on a specific object or situations predisposing one to respond in some preferential manner. This assertion implies that an attitude is the result of several beliefs a person holds and which makes him respond in a preferential way towards an object, event or situation. Attitudes are usually defined as a disposition or tendency to respond positively or negatively towards a certain thing (idea, object, person, or situation). They encompass, or are closely related to, our opinions and beliefs and are based upon our experiences. Since attitudes often relate in some way to interaction with others, they represent an important link between cognitive and social psychology. As far as instruction is concerned, a great deal of learning involves acquiring or changing attitudes.

According to Sax (1974), attitudes are perceived to belong to a negative-positive continuum. Anastasi (1998) was of the same view as Sax, when he stated that attitude is the tendency to react favourably or unfavourably towards a class of stimuli such as a racial or an ethnic group, a custom, or an institution. Anastasi added that a favourable reaction towards something means the person reacting has a good attitude towards the thing to which he or she is reacting, and vice versa.

Bert (1953) stated that any attitude is a hypothetical or latent variable rather than a variable that is immediately observable. It is, in other words, an abstraction. According to Bert, the concept of attitude does not refer to any one specific act or response of an individual, but it is an abstraction from a large number of related acts or responses. When we state that a certain individual, ‘A’, has a less favourable attitude towards a given subject for instance, than another individual ‘B’, we mean that A's words and deeds are consistently less favourable to the subject than B's words and deeds. So we conclude that there is an underlying attitude, which mediates between the stimuli (e.g. learning activities in the particular subject, which evoke comment or behavior) and the response (favourable or unfavourable comments, etc.).

Campbell (1950) emphasized the characteristics of attitude that are basic to all attitude measurement, i.e response co-variation, when he defines an individual's social attitude as an enduring syndrome of response consistency with regard to a set of social objects.

In his opinion, Katz (1960) defined attitude as the predisposition of an individual to evaluate some symbol or object or aspect of his world in a favourable or unfavourable manner. The structural hierarchy of attitudes is organized into value systems. This according to Katz is important because values are never completely isolated either from the individual or from the prevalent society.

A central characteristic of definitions of attitude is a statement of their enduring nature, a statement which implies that since attitudes change little, the processing of attitude information is minimal in the day to day usage of formed attitudes (Cappella & Folger, 1977). Studies have supported the idea that attitude is enduring over months, years, and even decades, given a reinforcing environment, but it remains difficult to account for either the variety and malleability of attitudes or their inconsistency in predicting behavior without appeal to some sort of quasi-continuous processing and reprocessing of information and attitudes (Cappella & Folger, 1977). If attitudes are reformed periodically on the basis of information, the question becomes one of how and what information is accessed and combined to form attitudes.

The question of "accessing" is attacked by Cappella and Folger (1977) with cueing. A cue according to these writers is a piece of information which is retrieved, through an attention connection, information from memory. Cues are generated through the information we receive from messages, communicators, and the context (situation) within which the message occurs. A cue directly accesses information related directly to the cue and indirectly accesses additional information connected to the directly cued information. By bringing information into the focus of attention, cueing provides access to beliefs, which can then be used in attitude formation, counter argument with a persuasive message, or simply thinking.

Cappella and Folger (1977) further maintain that cued beliefs concerning an attitude object are arguments. The affective connections to cued beliefs argue for specific attitudes. To them, attitudes are formed, in turn, on the basis of these arguments. Beliefs that are not cued do not, of course, affect the formation of those attitudes. If an individual's resources for processing information are, as researchers in human information processing claim, limited, then cueing makes sense as a mechanism for selecting a manageable subset from a large cluster of beliefs concerning an attitude object. This selection not only allows for variation in attitudes as cues change, but for the generation of highly context specific attitudes tailored to the specific situation. This enabled Cappella and Folger to define attitude as an evaluation of an object based on the accumulation of affective connections to arguments (cued beliefs). They also define Persuasion (Influence) as an attempt to change a person's attitude through the manipulation of cues.

Fazio's (1986) model of the process by which attitude guide behaviour is receiving a fair amount of attention in the social psychological literature. Fazio defines attitude as a learned association between a concept and an evaluation. Like any construct based on associative learning, attitude strength varies. Fazio indexes strength using a reaction time paradigm. The more rapidly an attitude can be expressed, the greater its strength. The stronger the attitude, the more accessible it is (Fazio as cited in Sorrentino & Higgins, 1986).

To guide behavior, attitudes must be accessible. Attitudes that are highly accessible from memory are much more likely to guide behavior than less accessible attitudes. Fazio, Sanbonmatsu, Powell & Kardes (1986) have demonstrated that accessible attitudes are activated spontaneously upon presentation of the attitude issue. Their emphasis on the automatic activation of attitudes differs markedly from Fishbein's view that attitudes result from a controlled effortful process of attribute consideration and evaluation.

Fazio and Williams (1986) have shown that correlations between attitudes and behavior are much higher among people with highly accessible attitudes. In one of their studies, accessibility was assessed by how quickly respondents rated the 1984 candidates for U.S. President. Four months later on the day after the elections, the respondents were asked if they had voted and for whom. Among voters with highly accessible attitudes, 80 percent of the variance in voting behavior was explained by attitudes; among voters with less accessible attitudes, only 44 percent of the voting behavior was accounted for by attitudes. Fazio and Williams believe that the greater consistency of the highly accessible group is a function of greater attitudinal stability. Highly accessible attitudes are linked to selective processing of information and even selective attention (Fazio, 1989 as cited in Pratkanis, Breckler & Greenwald, 1989; Roskos-Ewoldson & Fazio, 1992). To the extent that accessible attitudes are accessed each time an individual encounters the relevant concept, the attitude protects its holder against counter-attitudinal information and potential attitude/behavior. Accessibility is weakly related (0.30) to attitudinal polarity. Extreme attitudes do have a tendency to be more accessible. Accessibility, measured by reaction time to an attitudinal query, is a function of: number of previous expressions of the attitude; opportunities for review or rehearsal of the beliefs and behaviors associated with the attitude; direct experience with the attitude object; and anticipation of future interaction with the attitude object. Highly accessible attitudes are more difficult to change (Wu & Shaffer, 1987).

Attitude Formation and Change

The gradual movement from a point of having no attitude towards an object or a thing to a point of having some attitude towards that thing or object, whether the attitude is negative or positive, is what Oskamp (1991) refers to as attitude formation. He adds that attitude formation is a process and takes place either within a short or long time. When attitudes are formed they are further shaped by exposure. This is why mere exposure to an object or thing either increases or decreases our feeling towards that object (Zajonc, 1968).

Bornstein (1989) does not however totally agree with Zajonc. According to Bornstein, there is a limit to mere exposure and that mere exposure is most effective when it occurs in a random manner over time.

Apart from mere exposure, attitudes can also be formed through direct personal experience. According to Bordens and Harowitz (1995), direct personal experience has the power to create and change attitudes. When we encounter a personal experience such as overcoming pain with the help of a doctor, we may change our attitude towards doctors.

Attitudes according to social psychologists are not genetically acquired; they are mainly learned through personal experience (Aggarwal, 1994). The most influential media by which attitudes are learned include parents and siblings, peers and social organisations such as the mass media, the church, the mosque and indeed the school. In social learning theory, Bandura and McDonald (1963) explained that learning can take place by simple observation. To them, by watching the end results of other people's behaviour, learning can effectively take place to the extent that we can even draw differences between desirable and undesirable behaviours.

Katz (1960) cited two streams of thought regarding man's attitudes: one which minimizes man's rational powers and the other, which invokes a rational model of man. Katz, who clearly belongs to the second school of thought, asserts that at the psychological level, the reasons for holding onto or for changing attitudes are found in the functions they perform for the individual. The functions are those of adjustment, ego-defense, value expression and knowledge. It is true that the individual holds an attitude because it explains phenomena, and therefore in a very real way, Katz's assertion is true that an individual holds an attitude in order to give meaning to what would otherwise be meaningless and chaotic.

The adjustive function according to Katz embraces those attitudes that are utilitarian in origin and intent. Very often, the object is some tangible benefit. Often, too, these attitudes are affective associations based upon previous experience. A favourable attitude towards a certain food is based on pleasant memories of the food. We favour political parties that will advance our economic lot - if we are in business, we favour the party that will keep our taxes low, and if unemployed we favour one that will increase social welfare benefits. Similarly, a student will favour a particular academic programme if he or she believes it is what he or she will pass well in. We are more likely to change our attitudes if doing so allows us to fulfill our goals or avoid undesirable consequences (Katz, 1960).

Katz also describes the ego-defensive function as a situation where attitudes proceed from within the person, and that the objects and situation, to which they are attached, are merely convenient outlets for their expression. He cites the example of an individual who projects hostility to a minority in order to protect himself from feelings of inferiority. One common type of ego-defensive function is transference where an attitude adopted towards a person is not based on the reality of the situation. These ego-defensive attitudes stem basically from internal conflicts. Katz notes that one of the difficulties of ego-defensive attitudes is that the usual procedures for changing attitudes and behavior may not cause the individual to modify but may force him to reinforce his defenses, causing him to cling tenaciously to his emotionally held belief.

The value-expressive function of attitudes according to Katz, have the function of giving positive expression to central values and to the type of person an individual conceives himself to be. He explains that man, for instance, may think of himself as an internationalist. Attitude in keeping with this—favourable attitude, say, towards other countries—would have a value-expressive function for him. These attitudes may have a double function: they may be a confirmation of self-identity; and they may also help to mould the self-image "closer to the heart's desire." Favourable attitudes towards a group very often have a value-expressive function. The group gives the individual a sense of identity. Cohen (1964), in writing about the group as an important source of attitude change, states, "Many research findings which show that members of a group resist communications that run counter to the norms and values of the group and accept those sanctioned by it can be interpreted in terms of social approval or disapproval."(p.40). He contends that those who place a high value on their membership in the group are most vulnerable to threats of social punishment, for they have the strongest desire to maintain friendly relationships with the other members and to secure the prestige and privileges associated with their status as group members. Also of significance for social group workers is Cohen's finding that persons of low self-esteem tend to be more susceptible to influence from persons of higher self-esteem. A favourable attitude to the group may be value-expressive in so far as it gives a person of low self-esteem a sense of identity and by the same token opens him to the influence of the group.

Katz's functionalist theory also offers an explanation as to why attitudes change. According to Katz, an attitude changes when it no longer serves its function and the individual feels blocked or frustrated. That is, according to Katz, attitude change is achieved not so much by changing a person's information or perception about an object, but rather by changing the person's underlying motivational and personality needs.

Formation and change of attitudes are very much alike and can be said to be interwoven. People are always adopting, modifying, and giving up attitudes in order to fit their ever changing needs and interests. In fact, attitude cannot be changed by simple education. New attitudes are accepted depending on who is presenting the knowledge, how it is presented, how the presenter is perceived, the credibility of the presenter, and the conditions under which the knowledge is received (Halloran, 1967).

Attitude change can be a cognitive change, an affective change or a behavioural change (Traindis, 1971). Different media including the family, other people, the mass or electronic media, the church or mosque or the object itself can change attitudes. McGuire cited in Triandis (1971), developed steps to changing an attitude. These are: attention, comprehension, yielding, retention and action.

Traindis (1971) has also said “In analyzing the attitude change process, we must consider the effect of who says what, how, to whom and with what effect” (p. 144 -146).

Hovland, Janis, and Kelly (1953) provided one of the first major theories of attitude change, developed in the framework of Hull’s learning theory, and oriented towards the effects of persuasive communication. According to the Hovland’s et al theory, changes in opinions can result in attitude change depending upon the presence or absence of rewards. The learning of new attitudes is not different in nature from any other verbal or motor skill, except that opinions relate to a single proposition whereas other skills involve a series of propositions. The acceptance of a new opinion (and hence attitude formation) is dependent upon the incentives that are offered in the communication.

Heider (1958) developed a balance theory of attitude change that was influenced by Gestalt principles. In Heider's theory, when beliefs are unbalanced, stress is created and there is pressure to change attitudes. The two main factors affecting balance are the sentiment (e.g., liking, approving, admiring) and unity (e.g., similarity, proximity, membership) qualities of beliefs. Balance exists if the sentiment or unity between beliefs about events or people are equally positive or negative; imbalance occurs when they are dissimilar in nature.

Abelson (1968) developed the theory of cognitive consistency. Cognitive consistency suggests that people will try to maintain consistency among their beliefs and make changes (i.e., accept or reject ideas) when this doesn't occur. For example, if a student who wants to pursue a particular academic course and also wants to get good grades is presented with the fact that students who pursue the particular academic programme get poor grades; the student will either reject this proposition or change his attitudes about the particular academic programme or good grades. Theory of cognitive dissonance by Festinger as cited in Abelson (1968) is probably one of the best known and most researched frameworks pertaining to attitude change. According to this theory, attitude change is caused by conflict among beliefs. A number of factors determine the strength of the dissonance and hence how much effort is required to change attitudes. By manipulating these factors, attitude change can be facilitated or inhibited.

Measurement of Attitude

Measurement of attitude is a very technical area. This is because attitude is merely a concept which cannot be clearly seen. Attitude in most cases is implied from people's actions and behaviours. Attitude is classified under the affective domain. Its measurement is therefore quite distinct from other techniques employed in the measurement of variables in the cognitive domain. A number of attitude scales exist for the measurement of attitudinal levels. Whereas some of the scales employ direct responses in the form of self-reports, others employ indirect techniques.

Thurstone, a psychologist, was the first in the field of social psychology to develop attitude scales for the measurement of attitude (Mueller, 1986). Thurstone developed three scales for measuring attitude. These scales are:

a) Paired comparisons, which requires that attitude comparisons be paired in every possible combination.

b) Equal-appearing intervals, which also involve judging short statements one at a time on a range of extremely favourable to extremely unfavourable. Unlike the Likert scaling, this scale requires neutral items to incorporate the entire spectrum of attitude about an object.

c) Successive intervals. This is an extension to the equal-appearing interval scaling. It tries to statistically place items on a continuum instead of relying on subjective answers giving by judges. It uses the number of times different judges rate a statement to develop the rank order for the scales (Mueller, 1986).

Other people who also developed scales to measure attitudes include Likert and Guttman. Likert believed in constructing multiple scales, or narrowly defining scales so that other dimensions would not be included. He generated an item pool, which included statements about beliefs for the object in question. Each item was clearly positive or negative (Mueller, 1986).

Guttman's scale was much like those of Thurstone and Likert. However, he placed much emphasis on unidimensionality of the scale. Respondents must agree with all questions similar to one another.

Gender Related Attitudes in Science, Technology and Mathematics (STM)

The reality of the gross under-representation of sub-Saharan African girls and women in science mathematics, and technology (STM) fields is unsettling. The problem for Ghanaian girls and women mirrors the situation found in other sub-Saharan African countries. Although both men and women leave the "pipeline" along the way, studies have repeatedly shown that a higher percentage of women leave, especially during the undergraduate years (NSF, 1989; Siebert, 1992; NRC, 1991.)

According to educational statistics on Africa, in 1986, only 21% of students in mathematics and computer science, and only 6% of students in Engineering were women (Schmittroth, 1991). The issue of educational equity is still far from being achieved in many African countries, and women are systematically under-represented in scientific and technical disciplines at pre-university and university levels. In a number of African countries, girls and women's enrollment in science-based training and their involvement in science-based professions are among the lowest in the world (Adams & Kruppenbach 1996). A common assumption has always been that students who leave the sciences are less capable in the sciences than those who continue. The number of students graduating with Science, Mathematics and Engineering (SME) degrees is therefore believed to be determined by the quality of the students within the pipeline. However, studies have shown that ability is not always the deciding factor in determining the choice of programme in secondary school (Seymour, 1992). Seymour reports that Switchers (from SME fields) and non-switching seniors did not appear to differ in ability. They shared strong similarities in their self-reported mean GPA scores. Most switchers did not have more conceptual difficulties with science and mathematics, or inclination to work less hard, than the non-switchers (Seymour, 1992).

Research over the years has attempted to link the under-representation of women in science, mathematics and technology to a number of factors. Negative attitude towards science and mathematics is one of the many factors identified. Eshiwani (1983) for instance found a general negative attitude towards mathematics among Kenyan girls at the secondary school level.

Ma and Willms, cited in Campbell and Hoey (2000) found that attitude towards mathematics and science is the most important factor in determining if students will continue on in mathematics and or science from the 11th to the 12th grade. Campbell and Hoey again cites Simpson and Oliver to have found that at the high school level, attitude towards science and mathematics and a commitment to these subjects combine to serve as an extreme predictor in the choice of elective science and mathematics courses. Simpson and Oliver as cited by Campbell and Hoey added that once past elementary school, female students have been found to express more negative attitudes towards science and mathematics than males do, regardless of ability level.

Lips as cited in Campbell and Hoey (2000) has stated that the quality of girls' mathematics and or science experiences are related to their attitude towards mathematics and science, adding that at the college level, the quality of those experiences was found to be the variable most strongly linked to the level of women's mathematics and science participation. It is most likely therefore that mathematics and science experiences that include hands-on problem-solving will serve as a positive factor in girls' participation and retention in science and mathematics. Another possible reason for the under presentation of women in science has been the findings of Jovanovic and King in a study of 5th-8th graders in Columbia, as cited by Campbell and Hoey (2000). The study revealed that boys saw themselves as the more dominant class members in performance-based classrooms and monopolized the learning resources even when their grades were not different from those of girls. As a result, girls' perception of their own abilities decreased considerably over time.

In her study of secondary students, Aghenta (1989) found that a poor attitude towards STM was a barrier for the entry of many girls into the STM fields. In a related study of secondary and college students selected from seven state secondary schools and one federal college in Nigeria, Aghenta (1989) found that "perceived difficulties of science occupations" was a significant factor preventing girls from entering STM fields. A prior positive attitude towards STM according to Aghenta's finding, and a strong positive attitude towards science as found by Akpan (1986) all appear to play a critical role in whether African women will persist or drop out of the STM pipeline. Shakeshaft (1995) also noted that science and mathematics classes have expectations that simply exclude girls leading to lower participation and achievement.

It has also been found that female students harbor stereotypical ideas about science, mathematics and scientist in general. They tend to view the field of science and mathematics as male domains, often leading to the reluctance of girls to go into science and/or mathematics as a field of study or career, feeling that it is a male dominated field (Keller, 1985). According to Badger (1981), the traditional focus of science in Africa is male biased. To him, most science and mathematics problems have masculine content and therefore affect the motivation of most girls who see these problems as irrelevant to their interests. In a study of high school girls in Botswana (Duncan, cited in Mwetulundila, 1999) quoted one of the girls as saying

> Because of the social set-up, most of us want to be mothers and housewives. But most of the science which we are taught in our school is something which does not touch family life directly, or we don't do these things at home e.g. like proteins dividing into amino acids. When we come to family construction you don't have things like amino acids, and as a result we lose interest in it. So I think I have the ability to be the same as boys in science, but when we look at our future as mothers we don't seem to fit in the science they teach us in school, and so we lose interest (p. 7).

To increase girl's participation in science and science related disciplines, it is important to use girls' informal experiences as a bridge towards the realization of a gender balanced participation in the sciences.

Seymour (1992) noted that it is a common belief among first-year high school students that introductory science classes are "weedouts," and that such courses are designed to eliminate from the class those students who are not deemed "fit" to be in science, and that the perception of a "weeding out" atmosphere discourages many interested students from pursuing science in high school. Seymour adds that some teachers believe that a lack of certain attributes of ability and/or character distinguishes those who leave science, mathematics and engineering (SME) majors from those who remain in them, and that a widespread acceptance of this theory allows SME schools and departments to regard the falling out of girls as a kind of 'natural selection' process. On the contrary however, studies have repeatedly shown (Astin, Green & Korn, 1987, Astin, 1988; Green, 1989; Seymour, 1992) that many students who leave the sciences are intelligent and strongly motivated, but are discouraged by the competitive atmosphere and the belief that the department is trying to judge their abilities at an early stage. Although many classes are designed to set students in competition, students often respond more positively to an atmosphere of cooperative learning. In her research, Seymour found that over a third of high school students switching out of a science, mathematics or engineering field indicated that one of their primary reasons for leaving was that their morale was undermined by competitive culture (Seymour, 1993).

According to Gardner, Cheryl and Marsha (1989), Students are deterred from considering science as a career because of negative or narrowly defined images of scientists presented by the media and society in general. When hundreds of ninth and tenth graders were asked to draw a scientist, almost all drew pictures of a "nerdy" white male with a beard and glasses and wearing a white lab coat. With limited images of women as scientists, it is hard for young girls and women to imagine themselves in the field. Knowing a scientist personally may rather make a woman much more likely to pursue her interests in the sciences.

In an informal survey by the GISP at Brown University, the most important factor determining whether a woman will pursue science as a career was the vocation of her mother and or father. Armstrong however found that motivation to enroll in science; technology and engineering differed among males and females. For males, parental expectations for scientific and technical careers for their sons are the motivating forces while, for females, their own educational aspirations provided the drive to enroll. So, women have to be more self-motivated to choose these courses (Armstrong as cited in Tsuji & Ziegler, 1990). On this, (Mary as cited in GES, 1998) observed that on the selection of career paths, high school girls are more influenced than boys by; marks and self-evaluated ability, advice of parents and teachers, job opportunity, desire for career flexibility, balance career and family, and desire to make the world a better place.

Studies of junior high school students have shown that both sexes are unaware of career options and the educational requirements involved. If male students take courses due to parental pressure, they have still made the "right" choices. Female students, who need intrinsic reasons, would be less likely to have adequate information to guide their course taking. Therefore, educators need to stress the relevance of science and mathematics to students' career goals. If this is not done, high school girls tend to avoid taking the advanced science and mathematics necessary for careers in science and engineering (Tsuji & Ziegler, 1990).

Many people also have negative and narrow images of science as a discipline, career or a course of study. Many young people see the study of science (not medicine) as leading primarily to a field in the military. This is illustrated by numerous examples drawn from the military in college textbooks and in the media's portrayal of science. While this may be a positive connection, it probably appeals to more men than women and may give the impression that science has a very narrow range of applications. The positive benefits of Science and Engineering (S&E) research and development have not been the primary focus of the public image, nor have science and engineering been viewed by the public as ennobling careers. (NAS, 1989)

Students frequently believe that science classes are too difficult and too time consuming, without seeing the potential benefits of science or where a particular science course fits in the "big picture." This deters some students who are undecided in their area of study from ever taking a science class (Lantz as cited in Silverman & Pritchard, 1994). Lantz found that beliefs about math and science were also an important factor in the decision of girls not to take advanced courses or pursue such subjects as careers, despite their proven ability in these subjects. She found that stereotypes about subjects which have traditionally been identified as "masculine" are operating to discourage girls from pursuing nontraditional careers.

In a report on the findings of a two-year research project looking at girls' participation in technology education in Connecticut schools, Silverman and Pritchard (1994) observed that most of the factors which discouraged both boys and girls from taking technology education had a particularly strong impact on girls. The lack of knowledge of technological careers, the failure to connect what students were doing in class with future careers and the lack of a sense of economic realities were particularly discouraging to girls because they had less information about technology from experiences outside of school. Even more importantly, they had to overcome stereotypes about "appropriate" careers for women.

Silverman and Pritchard (1994) found a major difference in attitude between girls who chose to take technology education and those who did not. Only a few girls were willing to be "path breakers" and challenged stereotypes about nontraditional careers for women. Most girls could not picture themselves in technological jobs and were reluctant to be in classes where they were one of the few girls. Silverman and Pritchard thus concluded that these girls had never seriously considered taking technology education in high school, and that the fact that they could not picture themselves in technological jobs reflects the barriers set by sexism and the failure of schools to provide role models and positive programmes to overcome stereotypes.

An in-debt study in four African countries including Ghana and small-scale school studies in eight other African countries carried out by the Federation of African Women Educationalist(FAWE) through its Female Education in Mathematics and Science in Africa (FEMSA) project, indicate that fewer girls have access to education in Science, Technology and Mathematics (SMT) disciplines, especially in secondary schools, and that girls generally perform worse than boys in these subjects in both school tests and national examinations. The FEMSA School Studies revealed that girls are socialised from an early age in almost all communities, and in all of the FEMSA countries, to believe that science, mathematics and technology are male domains; that these disciplines require “struggle” and thus are not for the “weaker” girls; and that they are “difficult”. Thus it is believed that girls are innately incapable of performing well in these subjects. These attitudes are found among parents, teachers, and male students. It is therefore not surprising to find that the girls themselves come to believe the myth that SMT is only for boys and men (O’connor, 2000)

The study noted that many poorly educated parents, especially in the rural areas, want their girls to study those subjects which will make them good prospects for marriage. They perceive the study of mathematics and science as somehow likely to make their daughters “abnormal” and not conducive to making them good wives, mothers and homemakers. Among such parents there is also a commonly held view that girls are academically less capable than boys. Since girls are considered less capable, they often receive less encouragement and are rarely challenged at home or school to strive to succeed in their academic work. Poorly educated parents are also ill-equipped to help their daughters with subjects about which they themselves know little. They do not see the importance of the study of SMT subjects, and the development of a scientific and problem-solving approach to life’s everyday problems. They see the study of mathematics and science after school as taking an inordinately long time, and thus reducing their daughters’ chances of marriage.

The FEMSA study also revealed that many teachers, including women teachers, despite much lip service to the equality of girls and boys, just do not believe that girls have the ability to study mathematics and science. Teachers thus have very low expectations of girls' ability to perform well in SMT subjects. This is often revealed by the extent to which girls are ignored when questions are being asked in class, and in the fact that many questions addressed to girls do not require reasoning or serious understanding of the topic. Girls who give incorrect answers are simply ignored or passed over, while boys are challenged to struggle for the correct answer. The FEMSA study further revealed that among women who have succeeded in mathematics and the sciences, there is a strong belief that teachers actively discourage girls from studying these disciplines. Sometimes this is in a misconceived effort to spare the girls from difficulty and problems. In many cases it actually derives from the teachers' desire to spare themselves the trouble of having to "struggle" with girls, whom they believe cannot understand the subjects in anyway.

On attitudes of male students towards girls' participation in science and mathematics, the FEMSA study revealed that many male students do not believe that girls can cope with mathematics and sciences and in mixed classes they give their fellow female students a hard time through non-cooperation and active harassment. This attitude is graphically summed up by the taunt of a boy to a girl in his class who was top in Chemistry: "You will do very well in the Chemistry examination! But you will fail in the marriage exam"! (p.3). Unfortunately, many of the girls themselves subscribe to the view that these subjects are too difficult for girls. Furthermore, the girls believe that there are few opportunities for them in careers that are mathematics or science based. They also believe that, even if they succeed in making a career in these disciplines, they will not be allowed to attain their full potential in what they perceive to be male-dominated professions (O'connor, 2000).

In an attempt to explain factors that influence girls' attitude towards the sciences, Mwetulundila (1999) has blamed it greatly on what she called the hidden curriculum. According to her, children receive invisible lessons on sex role acquisition. Common forms of this seemingly invisible discrimination are found in textbook contents, classroom dynamics and the perceived masculine nature of some subjects. She adds that when mathematics and science are competing with other subjects on the timetable, girls are most likely, and indeed are usually influenced, to prefer other subjects to mathematics and science, though there may be a general apathy among students towards enrolling in the sciences. Mwetulundila cited the practice of some Namibian secondary schools where by girls are usually given the option not to take mathematics and or science if they wished, as some of the invisible discrimination against the feminine gender.

Society treats boys and girls differently from birth due to the stereotype, which seems to be confirmed by many research findings (Eccles, as cited in Crawford & Gentry, 89). Girls receive daily cultural cues that reinforce the stereotype of science and technology as a male domain. The stereotypical gender depiction begins early in life, with book images of children, and carries through to the portrayal of adults. These same old messages are carried by modern technology including print-based material, audio-visual material and electronic devices (Knupfer, cited in Mwetulundila, 1999). Eccles observed that most people including parents and even teachers consider male success in mathematics and science as evidence of innate ability, while girls' success in these disciplines is attributed to hard work compensating for lack of innate ability. These societal attitudes especially of teachers can have direct influence on students' participation and achievement in mathematics and science.

The stereotypical attitudes are especially deep rooted in Africa. For instance, Davidson, cited in Mwetulundila (1999) in a study of the attitudes of Malawian parents towards educating girls found a common view held by parents. To the parents, males were much more intelligent than their female counterparts and therefore the education of females became somewhat questionable to the parents. Many parents especially in rural areas share similar stereotypical attitudes towards girls.

As reported by Graber (1993), attitudes towards science and mathematics among students do not appear to be low during the lower grades of school. It however begins to fall among students in general and among girls in particular as they progress towards the upper grades and in the secondary school. In 1983 and 1984, Israel took part in the Second International Science Study (SISS) in which 82% of the 10-year olds and 66% of the 14-year olds said that science was interesting. Among the 17-year old students who chose to study science towards the matriculation examination, 72% found the study of Biology interesting while only 48% found the study of physics interesting (Tamir, Levine, Lewy, Chen, & Zuzovsky, 1988). The gradual fall in interest towards science as girls climb the academic ladder was further confirmed by Shemesh (1990) when he found that boys' interest in science and technology increased with age while older girls became less interested especially in the physical sciences, and that Israeli Junior high school girls tend to be more interested in language, social studies and humanities, while boys are more interested in science and technology. In the same trend, the U.S. Department of Education (1997) reported that while male and female seventh and tenth graders have similar positive attitudes towards science, high school seniors demonstrate a greater gap in their attitude towards science. Graber also notes that student's originally positive attitude towards science subjects change markedly in the upper grades, especially in chemistry and physics.

On the nature of students' attitude towards the sciences, Gardner (1974), in a review of gender differences in achievement, attitudes and personality of science students, stated that "there are clear differences in the nature of 'boys' and 'girls' science interests, boys expressing relatively greater interest in physical science activities, while girls are more interested in biological and social science topics" (p.243). Ormerod and Duckworth (1975) and Sjoberg (2002) corroborated these findings and indicated that it is very important to distinguish between the physical and biological sciences when gender differences in attitudes to science are considered. Tamir et al (1988) sought to clarify their use of the term "interest" as synonymous to attitude. They cited Gardner and Tamir as saying that:

> The term "interest" usually refers to preference to engage in some types of activities rather than others.

> An interest may be regarded as a highly specific type of attitude: When we are interested in a particular phenomenon or activity, we are favourably inclined to attend to it and give time to it. (p. 410).

Relating attitude towards science to interest in science careers, Catsambis (1995) noted that it is rather unfortunate that the less fovourable attitudes of females towards the sciences, as reported by the U.S. Department of Education, often translate into less interest in science careers. Catsambis further reported that young women begin to lose interest in science even when they perform as well, or even better, in this discipline compared to their male classmates, a situation which he lamented over and described as ironical.

In Ghana, like other countries, students follow a common curriculum until the end of grade nine (JSS 3) which is the last year of Basic Education. In Senior Secondary School (SSS), students select a major field of study on which they are evaluated at the end of the three year SSS course. Tamir et al (1988) has found in Israel, where the educational system is similar to that of Ghana that substantially more Israeli boys plan to study science-oriented subjects and choose science-oriented careers than girls. Lower numbers of girls opting for science and science-related subjects will continue to keep the number of females in science-based careers very low, a situation which Tamir et al. (1988) earlier described as a matter of concern primarily because of the adverse effect on the general education of high school students and the possible impact on vocational choice.

Effects of Science, Technology and Mathematics (STM) Intervention Programmes on the Attitudes of Participants

Literature outlining gender differences in science achievement, enrollment, and employment reinforce the need to focus efforts on attracting and retaining females in science. At the elementary and junior secondary levels, literature reveals that girls perform as well as their male counterparts until age 13, when they begin to slip behind in science achievement. (Connolly, Hatchette & McMaster, 1999) This gap increases each year until senior secondary school level, when females select few relevant science and mathematics electives, exhibit more negative attitudes and, by the end of high school, score considerably lower than boys in mathematics and science (Oakes, 1990).

Enrollment patterns at the secondary, post-secondary and graduate levels of education reveal a similar trend. Johnson (1987) observed that by university, women in Canada comprised only 22% of full-time students in engineering and applied sciences in 1997-98, up from 3% in 1972-73. Enrollment in mathematics and physical sciences rose from 19% in 1972-73 to 29% in 1997-98. By the graduate school level according to Johnson, the gender gap increases with women comprising only 23% of doctoral mathematics and physical science students, and only 16% of those in engineering and applied sciences. (Statistics Canada, 2000)

Women remain the minority in science careers, representing 21% of engineering, mathematics and natural science professionals in Canada. Regardless of educational attainment across all disciplines, female university graduates employed on full-time earned 73% of what men earned in 1997 (Statistics Canada, 2000).

Studies have shown that girls lose interest in mathematics and science in the middle grades (Catsambis, 1995; Farenga & Joyce, 1999). The promotion of positive science attitudes is therefore critical especially as science attitudes have been reported to be strongly related to long-term science achievement, (Weinburgh, 1995).

Literature indicates that intervention programmes for girls in the areas of science technology and mathematics have been relatively successful at developing positive attitudes towards these disciplines among participants, although longitudinal data are not available for most programmes (Dyer, 2004; McCormick & Wolf, 1993). However, intervention programmes have also been shown to increase girls' interest in only careers that use science to help others (Farenga & Joyce, 1999). Such careers often fall within the realm of the biological rather than the physical sciences. Different intervention programmes are organized for different purposes. Davis and Humphreys (1985) have put intervention programmes into five different groups: Short-term programmes, which serve to raise awareness and change attitudes. They may consist of speakers' series, one-day conferences, or workshops. Audiovisual and printed products, which are used as interventions to raise awareness, change attitudes, or increase knowledge. Films, filmstrips, videotapes, books, puzzles, exhibits, videodiscs, and career posters may be used to provide information about science careers in a concise manner. Experiential learning is used to give participants a hands-on experience in science or in a science-related field. Long-term interventions consist of courses and curricula. They are designed to increase learning as well as to change attitudes. Teacher education intervention programs may consist of summer institutes or in-service programmes. Their purpose is to modify the behavior of teachers and improve their skills so that, ultimately, the learning and attitudes of their students are improved. Some intervention programmes that can be classified under one or more of Davis and Humphrey's grouping are worth examining.

According to Laura (2002) one of the major findings of educational research in the 20th century was that girls tended to self-select out of the more difficult mathematics and science classes in junior high and high school, thereby limiting their options in college and careers. Laura, who started a "girls excelling in Mathematics and Science" (GEMS) Club for fifth and sixth graders in Virginia had an objective: to make club members realise that mathematics, science and technology were so interesting and full of fun and that these subjects were worth pursuing in high school classes and careers. In 1997, Laura carried out her first research study of the group, and found that in the short run, the girls, who were now in seventh and eighth grades, felt that mathematics and science were easier for them than they had previously thought. They also saw themselves as heading towards careers in these fields. One of the eighth grade girls said that Algebra had been hard for her in the beginning because it was so abstract, but that she was doing better after becoming a member of the GEMS club. She said, "Thinking in logic is hard" (p.2). Yet another girl said that her biggest difficulty in science was in drawing conclusions after the experiment was completed. When asked if participating in GEMS made mathematics or science any different – any harder or easier, each girl said that these subjects were easier. One girl said, "science has been an adventure" (p.3). Another said, "GEMS enriched my sixth grade" (p.3). A third girl said that she was more equipped to attack strategy and logic problems.

Laura further indicated that in 2002, as the first group of GEMS girls prepared to leave high school, she contacted 41 of the original members. She asked them about their course selections and their career plans. The findings according to Laura were fascinating. A comparison of the enrollment of these girls to the enrollment of girls who did not take part in the club revealed that indeed, these GEMS girls had chosen a higher percentage and many more of the higher level mathematics and science classes offered by schools.

In a study undertaken in Alberta, Canada to explore the impact of a junior high science intervention programme for girls with respect to their course and career plans, and attitudes and factors influencing female science retention, Terri (2005) reports that the Operation Minerva programme is effective at encouraging girls to pursue science as evidenced by 66% of participants reporting plans to enroll in secondary and post-secondary science and mathematics courses, and 90% reporting plans to pursue a career in science. An exploration of attitudes and factors influencing science retention revealed continuing concerns related to family- career balance and the positive impact of interest and ability, female science role models, applied science experiences, and parental support.

Penny (2000) reports of the relative success of a sisters in school programme in Philadelphia, an intervention programme for pre-secondary school girls in science and mathematics. The results of the interest, attitude, and awareness index were quite positive; i.e., the students showed very positive changes in attitude toward both school science and mathematics and toward the possibility of pursuing a career involving some aspect of science and/or mathematics. The generalized response that they “like school” was something of a surprise, but placed in the context of the program, can be taken as an indication of increased attitude. The pre to post results according to Penny can reasonably be taken as an indication of the success of the program in increasing the students’ interest, attitude, and awareness in science and mathematics.

In a study to assess the impact of a ‘Girls in Science Programme’ (GSP), Kathleen (2000) reports that the programme, which targeted 6^{th} grade girls who met monthly with female scientists in Cincinnati, produced positive results, based on which there was evidence that some aspects of the girls’ attitude and interest in science and science careers in addition to their intent to take science courses in high school did in fact improve over the course of the program. During the programme, the female scientists educated the girls on specific science topics and careers through hands-on activities and discussion while portraying the usefulness of their own careers to society. The girls also visited a local university and engaged in several activities in the labs of women faculty and students. For the last event, each girl created a poster titled “If I were going to be a scientist, I would be a.….” Unfortunately however, the longitudinal impact of the program on girls one or two years after completing the Girls in Science Programme (GSP) was not what was hoped, as the intent of the girls to take science courses in high school remained high but the significant changes observed immediately after the program in girls' attitude toward science and science careers receded back to what was observed on the pre-questionnaire.

In a series of research studies to assess the impact of its Camp's experience on participants' attitude and future intentions related to science, technology and engineering, ACTUA, a Canadian national charitable organization discovered that the overall impact of the camp on girls was very significant. The studies sought to find out among other things how girls view career opportunities in science and engineering, what influence participants' parents have on programme and or career decision and the effectiveness of ACTUA's all-girls' camps in encouraging girls to consider engineering as a career. The findings indicated that enjoyment of science appears to be a factor leading girls to a career in science. For some girls it is more important than being good at science, thus re-enforcing the importance of providing fun, and hands-on activities that excite and inspire young girls about science. When asked if they thought the science programme or a job as a scientist will be good for them, almost one-third (32%) of the girls thought the choice of pursuing the science programme or a job as a scientist would be a good choice. Of these girls, more of them identified 'liking science' than 'being good at science' as a reason for their choice. (32%) of the girls did not see themselves as scientists. Of these, 23% indicated "interested in other fields or subjects", as their reason for not choosing to pursue a science programme or a science career, 21% indicated "just don't want to" as their reason for not choosing science and 21% indicated "not good at science" as the reason for their choice.

The studies further revealed that ideas related to career aspirations of campers appeared to be formed at an early age. For instance it was found that many of the girls already had a notion of their career aspirations by the time they attended the camp. This was made evident through the answers to questions asking the girls if they thought a job as an engineer or a scientist would be good for them. For those not interested in science or engineering careers, interest in other fields was given as either the highest or second highest response. "Not knowing about engineering or what engineers do" was the highest response given by those girls who indicated that they were not interested in engineering. This reinforces the importance of increasing girls' knowledge about careers in science and engineering in this age group.

The ACTUA (2003) studies also collected data from girls whose parents were scientist or engineers and those whose parents were neither scientist nor engineers. Analysis of this data in an attempt to compare these two groups of girls revealed that girls whose parents are scientist or engineers appear to know more about science or engineering. When asked whether they thought a job as a scientist or an engineer would be good for them, 100% of the girls who responded that they didn't know much about science or engineering, and/or what scientist or engineers do, were girls whose parents were neither into science nor engineering.

Further findings from the ACTUA study was that girls identified four important reasons for being interested in a career in engineering. When the girls (pre-camp) were asked to rank items that would be important in order for them 'to be interested in engineering', they gave:

a) doing well in science and mathematics in school

b) knowing that your work will help people

c) having time for both a family and a career in engineering

d) Learning more about different kinds of engineering

as the top four reasons for being attracted to a career in engineering.

This finding reinforces the importance of creating awareness among girls on how engineering careers encompass the above factors. Any intervention programme aimed at changing girls' attitudes towards science related careers must therefore demonstrate clearly to girls how science and science related disciplines improve peoples' lives, and how other women balance their work and their families successfully.

In response to the concern of university professors, secondary school teachers, students, and professionals concerned with the small proportion of girls enrolling in engineering at the University of California, the University started a special Programme in 1968 dubbed "Mathematics, Engineering and Science Achievement" (MESA) for girls. It began with an initial pilot of 25 students after which it expanded to high schools and middle schools in a number of Californian states. Most of these programmes, especially the high school programmes aimed at keeping students involved, motivated, and informed about mathematics and science through academic tutoring, study groups, academic counseling, field trips, career awareness activities, role models, science projects, competitions, summer enrichment programs, and parent activities. An evaluation of the programme a few years later showed that over 90% of MESA high school girls in California went on to attend college with 60% going into mathematics or science-based fields. Over 30% of these girls were eligible for admission into the University of California, a rate almost three times higher than the 11.1% eligibility rate of all California students and a rate ten times higher than their non-MESA counterparts (Campbell & Hoey, 2000).

Originating in 1976 and coordinated by the Math/Science Network, Expanding Your Horizons (EYH) offers one-day conferences to junior high school girls as a way to provide girls with opportunities to learn from women in mathematics and science and to increase their interest in mathematics and science courses and careers. To date, over 390,000 girls have participated in the conferences, which combine role models, hands-on science activities and information on careers in science. An evaluation in California found that, after the EYH conference, girls were more likely to plan to take more than the required two years of advanced mathematics. A comparison study of EYH participation in North Dakota also showed that girls who attended the conferences tended to take advanced high school mathematics and science courses and had more positive attitudes towards math and science (Campbell & Steinbrueck, cited in Campbell & Hoey, 2000). In an attempt to increase the pool of minorities who are prepared to enter and complete post-secondary studies in engineering, mathematics and science the deans of six southeastern universities together established the South Eastern Consortium for Minorities in Engineering (SECME). The project has since expanded to include 34 universities, 74 school systems and 65 corporations in nine states and the District of Columbia. The model include among other things in-depth career exploration, role models and mentors, parental involvement and university exploration. Results from the survey of the programme showed that 91% of the respondents plan to enroll in four year college. Of that number 65% indicated they were planning to major in science, engineering or mathematics (Cambell & Hoey, 2000).

The Science, Technology and Mathematics Education (STME) Clinics

The under-representation of females in Science and Technology has been an issue of concern worldwide. The issue has been given attention at both the international and local level. Several international fora have been used to address the problem of gender stereotyping in the field of science and technology.

Between 1976 and 1980, the United Nations Educational Scientific and Cultural Organisation (UNESCO), organised four international meetings aimed at improving access of females to technical and Vocational Education and training. These were:

a) Expert Meeting on Educational and Vocational Guidance For Girls and Women held in Paris in 1976

b) International Congress on the Situation of women in technical and Vocational Education held in Bonn in 1980

c) International Seminar on the Opening up to women of Vocational Training and Jobs traditionally Occupied by men organized in Frankfurt in 1980

d) The International Seminar on Women, Education, Training and Employment in Developing Countries held in Tokyo in 1980.

The Vienna Programme of Action on Science and Technology for Development held in 1979 adopted resolution 2 on "Science, Technology and Women". The 1980 World Conference of the UN Decade for Women: Equality, Development and Peace, considered ways of merging the two issues, 'Science and Technology for development' and 'equal participation of women.' This also resulted in another meeting dubbed the ‘Expert Meeting on Science Technology and Women’ at Mt. Holyoke College, Massachusetts, and USA in 1983. The United Nations (UN) held the ‘End of the Decade’ Conference in Nairobi, Kenya, in 1985 to among other things examine extensively the issue of female under-representation in Science and Technology.

The issue has also received much attention Within the Commonwealth. In 1986, International Workshops and Conferences on Gender Stereotyping in Science, Technology and Mathematics Education (STME) were held in the United Kingdom and Singapore. Similar Workshops and Conferences were held in Ghana and Bangladesh in 1987. At the Tenth Conference of Commonwealth Ministers of Education held in Kenya in July, 1987, special emphasis was again placed on the particular need for girls and women to be provided with more opportunities and exposure to training in technical and Vocational areas and in various fields of science and technology.

A Commonwealth Africa Regional Conference was held in Accra in 1987.This provided participants with a unique opportunity to discuss at length, the incidence of and the reasons for such stereotyping in their countries, and also to develop action plans and strategies for addressing the problem. At the Accra conference which was held in GIMPA, a common concern among the participants was that misconceptions and negative attitudes contribute largely to the problem of low participation of girls in the study of science and mathematics at higher educational levels and consequently affect their choice of careers in the field of science and technology. Participants of this conference who were made up of women in Science and Technology, experts and policy makers from Ghana, Nigeria, Kenya and other African countries made certain recommendations to governments which included the encouragement of young girls through informal educational initiative, provision of incentives and counseling among others.

In response to the recommendations of the Accra conference, the Ghana Education Service (GES) organized the first STME Clinic for girls at Achimota School in Accra in 1987. Since then, STME Clinics have become an annual affair and have now been decentralized to the district levels throughout the country. The overall aim of the STME Clinic was to encourage girls to take up science and mathematics subjects, do well in them and stay with them. To achieve this, girls from basic and second cycle educational institutions are brought together in each district for a two-week intensive exposure to the scientific environment. During this time the girls interact with female scientists brought in as role models. Such interactions are intended to give the girls an opportunity to realise that it is possible to be a woman scientist and be a regular feminine individual. The girls visit institutions of higher learning in the sciences for a better understanding of the various subject areas. They also visit industries and scientific research institutions to acquaint themselves with the work environment. Other personalities are invited in to talk to the girls about job opportunities as well as problems one may encounter by working in male dominated areas, making them aware of what they should expect and what they need to do.

A later approach in the STME Clinic programme has been geared towards attaching girls to scientists and technologists in industries, factories, research laboratories and other fields of scientific endeavour. The girls select areas of interest after one week survey of science and technology fields. They then work alongside mainly women scientists and technologists for about four days to have a feel of working as a scientist. During this period too, girls work on projects as individuals or in groups to gain some skills in the working processes of scientists.

The Clinic session is usually started with a written exercise for participants. The exercise, which usually takes the form of responding to a questionnaire, is meant to unearth the misconceptions held by girls about the role of science in the life of girls and women.

Quashie (1998) have noted that the information gathered from the completed questionnaires year after year reveals that outmoded misconceptions and stereotyped attitudes are the major factors contributing to the negative attitudes on the part of girls towards the study of science. Other research findings indicate that society in general and girls in particular, consider science as a male domain - that science is either too mechanical or too technical for girls. Girls are also considered as not being able to think or work scientifically (Agholor, Jegede,Okebukula, Nkani, Eshun, as cited in Quashie, 1998).

The subjects studied in second cycle schools are perceived by students to be divided into two categories-those ‘suitable’ for male and those for female students. Technical subjects are considered ‘suitable’ for boys only and girls who study them are not considered ladylike. On the other hand, boys who study the so-called 'feminine subjects' like secretaryship, and Home Economics are laughed at by their friends and considered weak, lazy and poor achievers (Ellis, as cited in Quashie, 1998). It therefore appears that over the years, those who attempt to cross the gender barrier perhaps do so against several odds and only a few bold ones manage to succeed. Reports available at the office of the national coordinator of STME indicates that in some second cycle institutions the few boys who eventually decide to study the so-called ‘feminine’ subjects like food and nutrition are given names such as “Mr. Apron” whilst girls who choose to study technical subjects are called “Mrs. Hammer”. If this problem is allowed to continue, vast areas of job opportunities for male will avail, whilst opportunities for females will be very limited (Quashie, 1998).

Other findings from the annual pre-clinic exercises reveal that there is a general perception among girls that the traditional role of the woman is found in the home, therefore in school, girls should be taught subjects such as cooking and other vocational subjects to make them more capable of bringing up children, and performing household chores like cooking, washing, cleaning and being successful in their ‘God given’ reproductive and productive roles (Quashie, 1998). What the girls are however unaware of is that the activities referred to here are themselves science related.

Girls also appeared to have a negative perception about the nature of science and mathematics. Responses from the pre-clinic questionnaires indicated that girls consider science and mathematics to be difficult and require some kind of intellectual capability and physical energy, which women do not have. To the girls, this peculiar nature of science and mathematics implies that any girl who wants to study these subjects must spend longer hours and years of difficult work by the end of which there will be no suitors for her. Girls also seem to believe that those of them who eventually succeed in these subjects must be the most unattractive of their sex or that they must have some male characteristics (Quashie, 1998).

Choice of Academic Programme and Vocational Career among Female Students and Women

Many researchers have raised concerns about the under-representation of women in traditionally male careers (Kahle; Kelly, Smail, & Whyte; Science Council of Canada, cited in Sharon, 2004). According to statistics Canada as cited in Sharon (2004), few women, less than ten percent, are scientists, engineers or technologists in Canada and the United states. It further indicated that even in medicine and health related careers where women comprised 77.1% of those employed in these fields, most of the women in this area were nurses. In fact about 97% of nurses were found to be women as against 35% female physicians and 20% female dentists (statistics Canada, as cited in Sharon, 2004).

These statistics are alarming. With more women participating in the work force, why do they continue to work in a limited number of fields, such as nursing, secretarial, and clerical occupations? This question leads to another: what factors influence female students' decisions to follow traditional career paths? Perhaps more importantly, why do relatively few female students choose non-traditional science careers?

The trend of literature indicates that career choice among females tend to be influenced by a number of factors. According to Lunneborg as cited in Sharon (2004) and Young also cited in Sharon (2004), the strongest influence on females' career choice seemed to be their parents. If parents' expectations of their daughters were limited they often allowed their daughters to drop out of classes, such as mathematics and science classes, thus limiting their choices of non-traditional science careers (Basow; King; Lemkau; Young, all cited in Sharon, 2004). Albelushi (2004) confirmed this in his discussion of the role of gender in career choice, career development and commitment on the basis of interview data derived from a research study of female teachers in the Sultanate of Oman. He found that though family pressure and social traditions are not the only factors that influence career choice among Omani females; these factors no doubt remain very powerful.

Rice (1984) identified parents, peers, school personnel, intelligence, aptitude, interest, job reward/satisfaction, prestige, and sex role concepts as some of the factors influencing career choice. Gramstam and Sani (1984) noted in studies in Sweden that 56% and 25% of the female engineering students studied, had fathers who were engineers and brothers who were studying engineering respectively, and Godfrey (1991) in a study in New Zealand, found that 50% of the female engineering students studied had a family member or close friend who was an engineer. In fact, career choices, according to Osipow (1973); Niezer (1993) are a reflection of strong identification with the father.

To test the hypothesis that a woman is unlikely to become career-oriented unless some unusually potent set of influences has been operative, Simpson and Simpson (1961) compared the values and sources of personal influence which affect the occupational choices of career-oriented and non-career-oriented college women undergraduates. Though the findings on the strength of influence was not clear cut, it showed that the career women were considerably more likely than non-career women to attribute strong influence to teachers or lecturers (56% compared with 33%), and somewhat more likely to attribute either strong influence or some influence to people in the occupation. The career women were also more likely to attribute strong influence to parents and peers of the same sex. Generally, the career women tended to attribute strong influence to a larger number of people than the non-career women did. Sixty five percent of the career women but only twenty nine percent of the non-career women named three or more sources including both parents as having had strong influence on their occupational choice. Peers was one of the sources mentioned by career women as having strong influence on their occupational choice. Two possible inferences from the greater tendency of career women to name a large number of influences suggest themselves. This finding may mean that the career women, facing a possible conflict of roles felt a need for more support and therefore were more apt to seek out and perceive influences which support their career plans. It may also mean that they were more open to influence because they were more emotionally involved in the whole process of career choice, since a person who is deeply interested in any subject will be attuned to pick up cues related to it.

In summary, findings from the study by Simpson and Simpson (1961) seem to lend support to the basic idea that women who intend to pursue work careers through all or most of their lives have reached this decision because a rather special constellation of values and influences have been operative. Their occupational values and the sources of influence to whom they listen when making occupational decisions mark them off rather sharply from the more numerous group of women whose values are those of middle-class security and conformity and whose personal guides and models lead them into the more common feminine role- that of full time house wife and mother.

Although studies by Armstrong; Basow as cited in Sharon (2004) indicate that peers are not directly influential in the career decision process of females, Cohen and Cohen cited in Sharon (2004) argue that in an indirect way peers may have limited the career options open to female students if appropriate classes were not taken as a result of peer pressure.

Good, Brophy, Ha-verty, Jones & Wheatley cited in Sharon (2004) have said that the school could have an influence on the career choice of female students, explaining that if female students were treated differently in the science classroom than male students with male students being allowed to dominate the classroom, the female students may not adequately develop the skills or the confidence to consider a non-traditional science career.

It was unclear in the literature whether teacher gender has any influence on the career choice of female students. Whereas some studies indicated that female teachers influence the career choice of female students (Harlen, MacIver & Stake cited in Sharon, 2004), other studies indicated otherwise, arguing that though male and female science teachers might use different teaching styles, the impact of different teaching styles is unknown and more so whether or not students were aware of the different treatments was questionable (Harlen & Lawrenz, cited in Sharon, 2004).

A culture's dominant ideologies have a crucial influence on women's work. How a woman is viewed, what role she is expected to fill and what responsibilities she has or has been given are important in determining the extent to which she enjoys career opportunities (Drew & Emerek, cited in Drew & Mahon, 1998; Greenhaus & Parasuraman, cited in Powell, 1999). These authors cited Oman as an example where the strict definition of gender roles has traditionally restricted women's career and, frequently, academic choices. In such a society that places great importance on a woman's traditional role as care-taker, majority of females tend to choose a career merely because, to them it is 'suitable'. Parents in such societies, whenever possible, try to find jobs for their daughters that fit in with the dominant domestic pattern. The tendency therefore is for females to choose careers that are undemanding and compatible with domesticity.

Albelushi (2004) observed that from an early age, the Omani environment orients girls to teaching as the only, or as the most suitable work option, thereby constricting ambitions. He quoted an Omani female teacher who explained in an interview “there are no other fields for women here except teaching. Our parents and family put in our minds that we either become teachers or doctors”(p.18). Another female teacher said *“*It was the only alternative I had. My family prefers women to be teachers and I never thought of other fields” (p.19) These and other dominant feelings articulated by Omani teachers in a study by Albelushi are ones of frustration and injustice, and although the effect of socialization is powerful, the early exclusion of other employment options can leave a sense of opportunities lost, which may have the effect of damaging attitudes to work. This is because, as Albelushi puts it, this career was chosen by ‘default.’ Choice is closely linked to the identification of, and with career goals. However, if a goal is only such because it has been designated by others, then it is less a goal than a limitation: there is a sense of failure identified by respondents even before they started their careers. Choice is further limited not only by notions of suitability, but also by the respective levels of academic commitment of those careers that are considered suitable. Teaching and medicine may for instance be considered the most suitable, but the longer duration and greater difficulty of medical training, and the significantly more demanding nature of the job, means many females have little opportunity to make it their real choice.

Albelushi (2004) further noted that doing what others ‘expect’ creates a gap between the individual and society, and the individual and her career ‘choice’. This conformity creates an unusual relationship between the individual who chooses and his or her choice. It is unlikely that this relationship will be positive or creative. Albelushi who carried out a study on career choice and commitment among female teachers in the Sultanate of Oman quoted one of the teachers during an interview, to support his observation. In response to a question, the female teacher said

> Most of the things we do are not because we are convinced of them or a result of deep thinking. We do what others expect us to do. Teaching is one example. Society wants us to be teachers- not in any other job. However, if I thought about it or if I were given the chance to choose I wouldn't choose teaching. (p. 19).

Majority of those interviewed during the research confessed that they had not thought about their suitability for teaching when they chose to enroll in the College of Education. To them, the primary consideration was the appropriateness of the profession for women.

Bhatia (1991) has commented that most girls hesitate to go in for the science programme as this makes heavy demands both in matters of time and effort and thus deprives them of other interests and activities, adding that with the additional responsibility traditionally expected of girls at home, they are discouraged from aspiring to study in the sciences. Zietsman & Naidoo (1997) also confirmed that in South Africa girls are less interested in physics and mathematics than boys, and fewer girls choose to study these subjects at school and university, which severely restricts their entrance into engineering. Studies in Ghana (Baryeh, Obu, Lamptey & Baryeh, 2000) revealed a men: women ratio of

8 :1 in the School of Engineering at the University of Science and Technology, thus also confirming the assertion by Bhatia (1991).

A Botswanan study (Baryeh, Squire & Mogotsi, 1992) revealed that some women who qualify to study engineering decide to go into non-engineering fields due to lack of interest in the engineering field. Forty five per cent of the women studied were also found to have an objective to study engineering in order to become engineering practitioners, 42% wanted to work in other government institutions, 5.5% wanted to become engineering teachers, and 5.5% had no objective. Of the factors that influence girls to enroll in engineering programmes, the Botswanan study revealed that interest in engineering was the most influential, followed by availability of job opportunities in the engineering field, ability in mathematics and science, salary of engineers and their desire to assist in developing women's welfare. Other factors that were explored but were found to have negligible influence on girls' enrolment in engineering included parental advise, the community, the school guidance counselor, science teachers' advice, friends, and lack of any advice. However, When parental advice, the community, guidance counsellor and science teacher were put together and classified as a motivating factor from people, this composite factor became the second most influencing factor after interest in engineering. Studies in Ghana (Baryeh, Obu, Lamptey & Baryeh, 2000) have revealed that this composite factor had a higher influence on students' occupational choice than any other factor considered. The findings of the Botswana study regarding the factors influencing choice of engineering programmes are similar to findings in Ghana (Baryeh, Obu, Lamptey

& Baryeh, 2000) and in New Zealand (Godfrey, 1991; McWilliams, 1991) where it was found that the decision to study engineering was in most cases prompted by students' natural interest in engineering and the high mathematics and science abilities. Newton 1987; and Granstam 1988 have also reported that the decision to study engineering for young women overseas follows a recognised ability in areas such as mathematics, physics and chemistry rather than a long-held ambition to be an engineer. Amarteifio (1991) also found that women who went into engineering in Sierra Leone did so mainly because they were good in science and mathematics. The results of all these studies conform with the statement that a person's likes and dislikes, perceptions of his or her abilities, interest and values influence his or her choice of occupation (Ginzberg cited in Baryeh, Obu, Lamptey & Baryeh, 2000; Date-Bah, 1979; Rice, 1984)

Ginzberg as cited in Baryeh, Obu, Lamptey & Baryeh, (2000) indicated that the final choice of occupations compromises between interest, values, opportunities and limitations in the real world. Niezer (1993) further indicated that students' entry into and retention in the scientific talent pool, is a result of interest and abilities in science and mathematics.

One other finding of the Botswana study (Baryeh, Squire & Mogotsi, 2000) is that female role models have high influence on girls' career choices. Fifty six percent of the girls studied indicated that they have female role models whilst forty four percent indicated otherwise. Those who indicated they had role models confirmed that these role models encouraged and influenced them. A number of studies have shown that female role models have high influence on career choice of women. (Baryeh, Obu, Lamptey & Baryeh, 2000; Godfrey, 1991; McWilliams, 1991; Brown, 1991). In Ghana, the presence of female engineering lecturers as role models encouraged students to work harder (Baryeh, Obu, Lamptey & Baryeh, 2000). According to studies by Godfrey (1991) and McWilliams (1991), female students in New Zealand liked to have more women tutors. Brown (1991) has also reported the significant improvement in female enrolment in science and engineering in some American universities as a result of attending seminars given by women role models.

Gomile-Chidyaonga (2003) carried out a study to explore the experiences of young girls and women who have opted for Science and Technology related disciplines. The study, which was carried out in Malawi, was conducted in various training institutions which were Science and Technology bias and also in industries with Science and Technology related occupations. Most of the girls who participated in the study acknowledged the support of their families in their choice of career. Both parents (mother and father) were said to have been very supportive to their daughters' non-traditional career choices. For some, their male siblings acted as role models and provided a forum for the girls to test their skills and gain confidence. Parents were also instrumental in encouraging some of the young women to build a strong foundation in Mathematics and the sciences. Other girls were motivated by practicing professionals. For example, a young secondary school girl was reported to have been inspired to excel in the sciences by the only female pilot in Malawi at the time. The girls however said that their fellow girls reacted negatively towards their career choices, often retorting in some cases "why did you choose such a career" (p.11)

Most of the girls who participated in the Malawi study (Gomile-Chidyaonga, 2003) acknowledged that in order for girls to excel in science-related careers, they need to work hard in science and mathematics. Some girls pointed to the support and encouragement they received from parents from an early age. Other girls acknowledged the support they received from their teachers, who instilled in them the need, for example, to do more practice in Mathematics. The girls also acknowledged the fact that there are a lot more career opportunities for girls with qualifications in Mathematics and Sciences. They were also in agreement that Mathematics and Sciences were crucial subjects though difficult to master. They challenged the view that the sciences were not for girls, and said that those who subscribe to this view use it as a ploy to keep the girls out of lucrative careers.

The literature review has shown that a number of intervention studies organized for girls in the area of science, technology and mathematics suggests that these programmes are effective in changing attitudes towards these areas of learning. Both short term and long term intervention studies have shown positive contribution to greater female participation in science, technology and mathematics education. The literature review also shows that a substantial body of research on choice of academic programme and vocational career among the female gender in general seem to suggest that the choice of academic programmes and careers among females are influenced by several factors including home, societal and school- related factors.

CHAPTER THREE

METHODOLOGY

This chapter describes the procedure adopted in carrying out the research. It describes the design of the study, the population and the sample. The sampling technique that was employed to select the sample for the study is discussed. In addition, instruments used, and the procedure followed for the collection of data as well as the data analysis procedure are described.

Research Design

This study employed a mixed method design using both quantitative and qualitative research techniques. The use of combined methods according to Greene, Caracelli and Graham (1989) does not only promote triangulation in the classic sense of seeking convergence of results, but also complement each other so that overlapping and different facets of the phenomenon may emerge. A survey was used to collect data from STME JSS3 girls and non-STME JSS3 girls in the three districts chosen for the study. Aiken (1985) and Bauer (1985) have noted that the period close to the final examination is critical for final year students in terms of their development of attitudes towards school subjects. This is because they would have already selected the subjects which they want to pursue at the next educational institution, thus their attitudes towards the various subjects including mathematics and science would have been developed. This is why JSS3 students were chosen for the study.

An attitude scale on science and mathematics was completed by the students who were sampled for the study. Students' scores from these attitude scales were used for analysis. In order to investigate the issues more deeply, a qualitative approach was used. Twenty eight girls were selected from the original sample using simple random selection procedures. These girls were interviewed using a semi-structured interview guide. The individual interviews were recorded.

Considering the purpose of the study, it was necessary to gather information on some key aspects of students' attitude towards science and mathematics, such as patterns in the choice of courses, the utility of science and mathematics as well as their general view about these subjects especially how 'masculine' or 'feminine' they think these subjects are. To obtain adequate information from a reasonable sample of girls called for the use of the same questionnaires for both STME and non-STME girls. Drawing a representative sample from a large population was very necessary in order to allow generalisations about the attitudes of girls towards science and mathematics. After a careful consideration of what the study sought to do, the descriptive survey method was deemed most appropriate.

As stated earlier in this section, a second data collection method was used as a sort of complement to the survey method. This provided further understanding into the variables being investigated and helped to validate whatever findings emerged from the use of the quantitative method.

Population

The target population for this study was all girls who attended the 2004 STME clinic and those who did not attend, in 34 JSS. These schools were distributed across two Districts and one Municipality. Whereas most of the JSS in the Bawku Municipality had urban characteristics, those from the Bawku West and Garu-Tempane Districts were mostly rural schools with relatively smaller enrolments. The schools in the Bawku Municipality had students from Bawku Township and its environs while students of the schools within the other two Districts were from rural communities that were somewhat distant from each other. All the schools are however located within the same traditional area and therefore have similar characteristics. The pupils share similar socio-economic and cultural characteristics.

Sample and Sampling Procedure

The sample for the study was drawn from all the 34 JSS from which students were selected for the 2004 STME clinic. In each school, the JSS3 girls were put in two groups, those who participated in the 2004 STME clinic and those who did not. There were 360 STME girls and 420 non-STME girls. The sample for the study was then selected using proportional stratified sampling. This procedure yielded a total of 103 girls who had attended the STME clinic and 120 who did not attend the clinic, thus making a total of 223 girls. The STME girls had a mean age of 16.4 years and a standard deviation of 5.6, while the non-STME girls had a mean age of 16.5 years and a standard deviation of 1.5.

To delve deeper into the attitudes of STME and non-STME girls towards Science and Mathematics, 28 girls were selected from the main sample for a one-on-one interview. First, 10 JSS were selected from the 34 JSS by simple random sampling. The 34 schools were numbered after which the numbers were written on equal sized pieces of paper and put into a container. Ten students were randomly called to pick out a paper each and these were the 10 schools that were selected. Then using the list of STME and non-STME girls as sampling frames, 28 girls (14 STME and 14 non-STME) were selected by simple random sampling from the 10 JSS.

Instruments

Three instruments were used for the study. Two were adapted from Fenema & Sherman (1976) whilst the other one was developed by the researcher. These were:

(a) Mathematics attitude scale instrument

(b) Science attitude scale instrument

(c) Semi-structured interview guide

Mathematics Attitude Scale Instrument (MASI)

The MASI was first constructed by Fennema & Sherman (1976) in an attempt to study students' attitude towards science. This instrument served as a guide to the researcher in the construction of a similar instrument for the study. The original instrument has a wide range of coverage. It covers among other things confidence in mathematics, usefulness of mathematics, mathematics as male domain and teachers' perception of students' mathematical capabilities.

However, upon a critical examination, items that sought to elicit information from students about the perception of their teachers regarding their (students) mathematical capabilities were found to be irrelevant for this study since this study is about attitudes and not perceptions, hence such items were excluded from the instrument for this study. Ten of the items were constructed to find out whether students consider mathematics more as a male domain or a female domain. These items were deemed necessary because mathematics is commonly considered as a masculine subject and therefore incompatible with a female self-image (Fennema & Sherman, 1977; Sherman, 1982).

Ten other items were constructed to collect views regarding the usefulness or otherwise of mathematics both in school and out of school. It sought information on whether students see the study of mathematics in the JSS as an imposition and whether they would have studied it if it were optional. Fourteen items were also constructed to collect information on whether male and female students had confidence in themselves in the study of mathematics.

Whereas the original mathematics attitude scale constructed by Fennema & Sherman (1976) contains 47 items, the modified scale for this study was made up of a total of 34 items. These items served as a guide for the construction of the Mathematics attitude scale for this study. Items that were considered relevant for the present study were adapted but reworded to ensure that they were understood by JSS 3 students. Rules for constructing items for a questionnaire (Mahr, cited in Sarantakos, 1998) were considered in the construction of the items for the scale. The rules included the following:

a) Every question must be relevant to one or more aspects of the study.

b) Ambiguous, non-specific and hypothetical questions should be avoided.

c) Leading, double-barreled and presuming questions should not be employed.

d) Embarrassing, personal or threatening questions should be avoided.

e) Vague words and academic jargons should not be used.

f) The language of the respondent should be employed without complicated expressions.

g) Easy flow and logical progression in the questionnaires should be assured.

h) Each question should ask what it is supposed to ask.

The Mathematics attitude scale was made up of an equal number of positive and negative items. Each positive item on the MASI was scored on a four point Likert-type scale as follows:

Strongly Agree	=	4
Agree	=	3
Disagree	=	2
Strongly Disagree	=	1

Scoring was reversed for each negative item as follows:

Strongly Agree	=	1
Agree	=	2
Disagree	=	3
Strongly Disagree	=	4

With this scoring system, higher scores are associated with positive responses whilst lower scores are associated with negative responses. To establish validity for this scale, the draft items were made available to experienced science and mathematics lecturers who made valuable suggestions to improve the instruments. They also suggested the replacement of some of the items with others which were more capable of eliciting information about attitudes. Some items were reworded to ensure that JSS3 students could understand and provide well informed responses. Forty seven items were drafted and given to the lecturers out of which only 34 were recommended for use in this study.

The MASI had two parts. The first part collected data on the background information of respondents such as; name of respondent's school, age of respondent, career choice of respondent, plan for further education and choice of academic programme. The second part surveyed the attitude of respondents towards mathematics, with items such as; "I am sure that I can learn mathematics", "I feel no matter how serious I become, I can't do well in mathematics", "I am good in mathematics", "Boys are naturally better than girls in mathematics", etc. The MASI is shown in Appendix A.

The MASI was pilot tested to establish its reliability. The pilot test was carried out in two JSS schools in Bolgatanga District using 30 JSS3 girls made up of 15 STME and 15 non-STME girls. With the aid of Statistical Package for the Social Sciences (SPSS), the internal consistency of the instrument was calculated using Cronbach's alpha. An alpha level of 0.85 was obtained. This was slightly above that of the original instrument (0.82). Considering the alpha for this instrument, the researcher was convinced that the instrument was good enough, but still subjected it to further analyses.

In order to refine the MASI, the result of the pilot test was further subjected to item analyses. The results of the item analyses was critically examined to find out if the internal consistency of the instrument could be improved by removing all items that reduced the alpha value. This analyses revealed that for each item, the correlations between it and the rest of the items excluding that item, was satisfactory, and would not significantly improve the alpha value if the item were deleted. In particular, each item was below 0.85, hence, all 34 items were maintained and used for the study.

Science Attitude Scale Instrument (SASI)

To provide tools to examine a student's attitude towards science, Fennema and Sherman (1976) constructed a scale (the science attitude scale), similar to the MASI. The construction of the SASI for this study was done under the same principles as that of the MASI. Like the MASI, the SASI had a wide range of coverage. Items that covered some areas were considered by the researcher to be relevant for this study. These areas were the mathematics as a male domain, the usefulness of mathematics and confidence in mathematics. The items on teachers' perception was, as in the case of the MASI, were found to be irrelevant for this study since this study is about attitudes and not perceptions, hence such items were excluded from the instrument for this study.

The SASI was made up of various items which basically sought to measure attitude towards science in terms of the usefulness of science, confidence in science and whether science is considered as a discipline for one particular sex group or for both sex groups. There were 8 items the usefulness of science, 12 items on confidence in science and 13 items on whether science is for masculine or feminine gender. Thus the SASI consisted of 34 items, made up of an equal number of positive and negative items. The construction of the items, as in the case of the MASI, was guided by the original instrument by Fennema and Sherman (1976). Some items were adapted to suit the study. Mahr's rules for item construction for a questionnaire which guided the construction of the items in the case of the MASI were also employed to guide the construction of the SASI. The items on this attitude scale were scored on a four-point Likert-type scale with Strongly Agree, Agree, Disagree and Strongly Disagree corresponding to 4 points, 3 points, 2 points and 1 point respectively in the case of positive items. Scoring was reversed for negative items.

The SASI was used to survey the attitude of respondents towards science, with such item as; "I am sure that I can learn science", "science is one of my best subjects", "I don't think that I can do science beyond SSS", etc. The science attitude scale is shown in Appendix B.

Validity for the SASI was established through the use of expert judgment. The draft instrument, made up of 47 items was given to three science educators in the University of Cape Coast. After going through the instrument, 13 items were rejected by each of the three lecturers. Thirty four items were finally used for the study but with some of these items reworded to enhance clarity and understanding among the target group.

This instrument was pilot tested alongside the mathematics attitude scale. The same respondents were used for the pilot test. They completed both instruments one instrument after the other after which both instruments were collected from them by the researcher.

To determine the reliability, the completed science attitude scale was analysed using SPSS. After analysis, the instrument had a Cronbach's alpha of 0.91 which was higher than the alpha for the original instrument (0.83). Like the mathematics attitude scale, the science attitude scale was further subjected to item analyses to find out if individual items decreased the overall alpha.

Item analyses procedures were conducted on all the 34 items that made up the Science attitude scale. All the items had reliabilities greater than 0.91, hence deleting any of them would not improve the overall reliability of the instrument. All the 34 items were therefore used for the main study.

Semi-structured Interview Guide

A semi-structured interview guide was used for data collection. This was designed to collect data from a group of 28 girls selected from the main sample as earlier on described under the section on sampling and sampling procedure. The decision to use the semi-structured approach to interviewing stemmed from the desire to gather descriptive data in respondents' own words so as to gain insight into the attitude of JSS3 girls towards science and mathematics. The interview guide had 12 main questions. Some of these questions had follow up questions. In general, the interview sought to explore the experiences of the respondents in STME Clinics and to find out if these experiences had had any positive effect on their interest in science, mathematics and technology and in terms of their choice of programme of study beyond the JSS level. The interview guide also sought to find out if science and mathematics were considered to be equally good for both boys and girls, and what the girls thought about job availability for people who read science or mathematics in school.

The interview guide provided the researcher the opportunity to ask follow up questions in order to raise issues of particular concern to the study. The interview guide is shown in Appendix C.

Validity for the interview guide was established through expert judgement. The same lecturers who validated the MASI and the SASI also read through the interview guide and made various suggestions which were considered. The interview guide was also pilot tested on five selected JSS3 girls. Some questions that were not very clear to the girls were reworded.

Data Collection Procedure

The data collection was carried out in April, 2006. Before data collection, permission was obtained from the Directors of Education for the Bawku Municipality, the Bawku West district and the Garu-Tempane district. This was done using an introductory letter from the Department of Primary Education. The researcher also contacted the officer in charge of the STME Clinic in each of the three districts to collect information about the girls who attended the STME clinic in 2004. The STME participants for the 2004 Clinic session were in their final year at the time this study was conducted. The data was collected in two phases. In the first phase, data was collected from JSS3 girls in 34 Junior Secondary

Schools. An average of three schools was covered each day with an average of three girls in each school. An average of two hours was spent in each school. In each school, the MASI and SASI were distributed to all STME JSS3 girls and their colleague non-STME JSS3 girls who were selected for the study. The girls were instructed to complete the MASI first after which they complete the SASI. Both instruments were completed at the same sitting, but one after the other. Respondents used an average of 45 minutes to complete each set of questions (MASI and SASI). In all, 223 of each set of questions were given out. There was a 100% return rate owing to the fact that the researcher personally visited each school to administer the questionnaires and collected them back immediately each person completed responding to each set of questions.

In the second phase of the data collection, 28 girls made up of 14 STME girls and 14 non-STME girls were interviewed. A day after the administration of the two attitude scales were completed, the researcher began a face-to-face interview with each of the 28 selected girls. This exercise lasted for a week. Before the interview with each student, the researcher spoke to the student about the reason for the interview and the need to record the interview. Each student was assured that the recorded interviews would be treated confidentially. Each interview lasted for a period of between 30 and 45 minutes and was recorded using an audio-tape recorder.

Data Analysis

Responses to the first part of the attitude scales which collected data on choice of future career and programme of study were coded and analysed statistically to reveal the choice pattern among STME and non-STME girls. The analysis was done using means and percentages.

Responses to both attitude scales for both group of students were also coded and analysed using statistical package for the social sciences (SPSS)

Differences between the attitude of STME and non-STME girls towards science was analysed using independent t-test. Differences between the attitude of STME and non-STME girls towards mathematics was analysed in a similar way.

Qualitative data collected through the interview were first transcribed. The transcription process was useful to the researcher as it made him become familiar with obvious patterns that unfolded. This facilitated the analysis process.

The analysis involved identifying themes and patterns that emerged from the data. These themes and patterns were then interpreted to amplify the quantitative data in order to give further insights in attitude of STME and non-STME girls.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the analysis and discussion of the data. Two research questions and two hypotheses were posed. Both descriptive and inferential statistics were used for the analysis. Descriptive statistics was used to analyse the first research question. The second research question was however analysed qualitatively. The two null hypotheses that were formulated were tested using a t-test at 0.05 level of significance.

Quantitative Analysis

Differences between STME and non-STME JSS3 Girls' Choice of Programme of Study for SSS and Future Career

Research question one sought to find out if STME and non-STME JSS3 girls differ in their choice of preferred programme of study for SSS and future career. Table 1 shows the results of respondents' choice of preferred career.

The careers selected by the respondents fell into 11 categories. These careers were in the Sciences, Law, Agric, Education, Nursing, Catering Accountancy, Music and Journalism. Out of the 223 girls who constituted the sample for the study, 46.2% attended the STME clinic in 2004. Table 1 shows 63.1% of the STME attendants indicated their preference for science-based careers with the rest preferring non-science based- careers.

Table 1

Percentage Distribution of Respondents' Preferred Career (N=223)

Career	STME		NSTME		Total	
	No	%	No	%	No	%
Doctor	24	23.3	21	17.5	45	20.1
Nurse	37	35.9	28	23.4	65	29.1
Engineer	2	1.9	-	-	2	0.9
Agriculture	1	1.0	-	-	1	0.5
Pilot	1	1.0	4	3.3	5	2.2
Teacher	12	11.6	26	21.7	38	17.0
Journalist	5	4.9	11	9.2	16	7.2
Accountant	16	15.5	22	18.3	38	17.0
Lawyer	3	2.9	5	4.2	8	3.6
Musician	1	1.0	1	0.8	2	0.9
Caterer	1	1.0	-	-	1	0.5
Police	-	-	1	0.8	1	0.5
Trader	-	-	1	0.8	1	0.5
Total	103	100	120	100	223	100

The non-STME girls also indicated interest in all except three of these careers. One person indicated preference for the Police Service whilst another person expressed desire to be a trader. The non-STME girls constituted 53.8% of the sample. Of this number, 44.2% indicated preference in science related careers with the rest indicating preference for non-science- based careers.

Table 1 shows slight differences in the pattern of choice of preferred future career for STME and non-STME girls. Whereas a greater percentage of STME girls (63.1%) preferred science-based careers, (36.9%) indicated their preference for non-science-based careers. The opposite is true for non-STME girls where more non-STME girls (55.8%) preferred non-science-based careers compared to 44.2% who preferred science-based careers. Despite these slight differences, some similar patterns have emerged. In the case of STME girls, 93.8% of those who preferred science-based careers indicated preference for medical practice and nursing. This is also true for the non-STME girls where 92.4% of those who preferred science-based careers chose medical practice and nursing. In each case the proportion of girls who chose nursing far out numbered those who chose to be Doctors. This finding is confirmed by the observation by Statistics Canada (cited in Sharon, 2004) that even in medicine and health related careers where women comprised 77.1% of those employed, most of the women (97.7%) are nurses, with only 35% and 20% of women being Physicians and Dentists respectively. Educational statistics on Africa in 1986 reported a similar pattern citing only 21% of students in mathematics and computer science and only 6% of students in Engineering were females (Schmittroth, 1991). The finding of Zietsman & Naidoo (1997) that South African girls are less interested in the physical sciences compared to other aspects of science and that this has led to fewer girls choosing to study in the physical science related fields is confirmed in Table 1.

Though the survey did not seek reasons for the various choices made by respondents, the pattern of responses suggests that either the girls were interested in fields other than those in the Physical sciences or that they did not even know about the Physical sciences or what physical scientists do.

Another pattern that is true for both STME girls and their non-STME counterparts is that majority of the STME girls (73.7%) who preferred non-science-based careers indicated their preference for teaching and accountancy. For non-STME girls, 71.6% of those who opted for non-science-based careers preferred teaching and accountancy. Thus girls who do not prefer science related careers showed interest in teaching and accountancy than other professions.

It can also be observed from Table 1 that most STME and non-STME girls did not show interest in engineering, agriculture and piloting. Among the STME girls, only 2 chose engineering, and one chose agriculture, but no non-STME girls preferred these careers. Again, only one STME girl preferred piloting with 4 of their non-STME counterparts preferring the same career. This may have implications for the STME clinic for girls. There is the need to make girls aware of these careers and to encourage them to develop interest in pursuing them.

Table 2 also shows the results when respondents were asked to make a choice of the academic programme they wish to pursue at the SSS level.

From Table 2, 45.6% of the STME girls indicated their desire to pursue the sciences if they got admitted into the SSS. The rest of the 54.4% preferred non-science programmes. The case was not different among non-STME girls. Whereas 30.1% of the non-STME girls preferred science related programmes if they got admitted into the SSS, the rest preferred non-science related programmes. Of the 223 girls who constituted the sample for this study, only 23.3% indicated their preference for the General science programme. 31.1% of those who chose General science were STME girls with 16.7% being non-STME girls. Among the non-science related programmes, General Arts and Business were the most favourable programmes for both STME and non-STME girls. 57.1% of STME girls who chose non-science programmes chose general arts and business. Similarly, 52.4% of non-STME girls who chose non-science programmes opted for general arts and business.

The patterns that have emerged from the table show some differences between STME and non-STME girls in their choice of programme of study for SSS. More non-STME girls than their STME counterparts chose to pursue non-science related programmes if they get admission into the SSS. This finding confirms the finding by Penny (2000), Kathleen (2000), Laura (2002) and Terri (2005) who reported that various intervention programmes have been successful in making participants to choose to pursue science-related programmes at various levels.

The choice patterns that have emerged suggest that the STME participants have expressed more desire with regards to pursuing science related programmes at the SSS. It confirms findings by Campbell and Steinbrueck, (cited in Campbell and Hoey, 2000), who evaluated a programme in California dubbed

Expanding Your Horizon (EYH), which offered one-day conferences to junior high school girls as a way of providing them with opportunities to learn from women in mathematics and science and to increase their interest in mathematics and science courses and careers. After the conference it was found that girls were more likely to plan to take more advance mathematics and science courses in high school than before.

Table 2

Percentage Distribution of Respondents' Preferred Programme of Study (N = 223)

Programme	STME		NSTME		Total	
	No	%	No	%	No	%
Gen. Scien.	32	31.1	20	16.7	52	23.3
Agric.	15	14.5	14	11.7	29	13.0
Technical	-	-	2	1.7	2	0.9
Gen. Arts	32	31.1	44	36.7	76	34.1
Business	21	20.4	35	29.1	56	25.1
Vocational	3	2.9	5	4.1	8	3.6
Total	103	100	120	100	223	100

A note worthy outcome from Table 2 is the very negligible numbers who chose to pursue Technical and Vocational programmes. From Table 2, while no STME girl chose the Technical programme, only 2 of the non-STME girls chose this programme. Similarly, the STME and non-STME girls who chose the Vocational programme were 3 and 5 respectively.

From Table 3, 88.8% of the total number of girls who participated in the study chose to proceed to the SSS if they obtain admission. 93.2% of the STME girls chose to go to SSS compared to 85% of their non-STME counterparts who chose the same option.

Only 1% of the STME girls preferred to go to Technical school, while 5.8% of them chose to pursue Vocational education when they finish JSS. 5.8% of the non-STME girls opted for Technical education with 6.7% of them opting for Vocational education.

Table 3 shows that majority of the girls planned to proceed to the SSS and that there is no much difference in the proportion of STME and non-STME girls who chose to go to SSS.

Differences between Attitude of STME and Non-STME JSS3 Girls towards Science

Hypothesis one was formulated to test if there was any significant difference between the attitude of STME and non-STME girls towards science. Table 4 presents results of an independent sample t-test conducted to compare the science attitude scores for STME and non-STME girls at 0.05 level of significance.

Table 3

Percentage Distribution of Respondents' Plan for Further Education (N = 223)

Plan	STME		NSTME		Total	
	No	%	No	%	No	%
Go to SSS	96	93.2	102	85	198	88.8
Go to Tech. sch.	1	1.0	7	5.8	8	3.6
Go to Voc. Sch.	6	5.8	8	6.7	14	6.3
Learn a Trade	-	-	3	2.5	3	1.3
Total	103	100	120	2.5	223	100

Table 4 shows that there was a significant difference between the attitude of STME girls (M = 114.34, SD = 13.78) and NSTME girls [M = 102.83, SD = 14.41; t (221) = 6.07, p = .001]. The effect size of the significant difference was moderately weak, r = 0.38.

Table 4

T-test on the difference between the Science Attitude Scores of STME and NSTME Girls (N = 223)

Group type	N	M	SD	df	t	p
STME	103	114.34	13.79	221	6.07	.001*
NSTME	120	102.83	14.41			

*Significance P< .05

The eta square index indicated that 14% of the variance of the attitude towards science was accounted for by whether a student had attended STME or not. In the light of this result, the null hypothesis was rejected. The alternative hypothesis, that there is significant difference between the attitude of STME and non-STME girls towards science was therefore accepted. The results therefore suggest that the non-STME girls had a less favourable attitude towards science compared to their STME counterparts.

Difference between Attitude of STME and Non-STME JSS3 Girls towards Mathematics

Hypothesis two was formulated to test if there was any significant difference between the attitude of STME and non-STME JSS3 girls towards mathematics.

The difference between the means of the two groups was tested using the independent sample t-test at 0.05 level of significance and the results are shown in Table 5. The results shows that there was a significant difference between the attitudes of STME girls (M = 110.6, SD = 14.13), and non-STME girls [M = 102.2, SD = 14.90; t (221) = 4.26, p =.001]. The effect size of the significant difference was weak, r = 0.28. The eta square index indicated that 7% of the variance of the attitude towards mathematics was accounted for by whether a student had attended STME or not. This result led to the rejection of the null hypothesis. The alternative hypothesis, that there is significant difference between the attitude of STME and non-STME girls towards mathematics was rather accepted. The conclusion therefore was that the two groups differed in terms of their attitude towards mathematics, and that the difference was not due to chance. This results contrasts sharply with the negative attitude of girls towards mathematics as was often reported by the STME co-ordinators after the administration of pre-STME Clinic questionnaires to participants each year (GES, 1998). This suggests that the STME clinic have had a positive influence on its participants and may contributed to the higher positive attitude towards mathematics compared to the non-STME girls.

Table 5

T-test on the difference between the mathematics attitude scores of STME and NSTME Girls (N = 223)

Group	N	M	sd	df	t	sig
STME	103	110.55	14.13	221	4.26	.001*
NSTME	120	102.23	14.90			

*Significance P < .05

The common concern among participants of the 1987 Africa Regional Conference held in GIMPA, Ghana was the contribution of misconceptions and negative attitude to the low participation of girls in the study of mathematics and science at higher levels of Education and which at the long run affect their choice of career in Science and Technology. This concern suggests that at that time, there may have been a general poor attitude towards mathematics and science. The finding that STME participants have demonstrated higher positive attitude towards mathematics is therefore very significant. The results of the career choice and choice of academic programme which showed that in both cases, more of the STME girls wanted science related careers and programmes compared to the non-STME girls, is another important finding.

The STME clinic has always been planned with various hands-on activities to give practical experiences to the participants with the aim of making them realize that science and mathematics are quite simple and highly related to everyday life situations. The quality of such experiences may be able to help participants to develop positive attitude towards science. This observation has been made by Lips, cited in Campbell and Hoey (2000) that the quality of girls' mathematics and science experiences are related to their attitude towards science and mathematics. Lips found that at college level, the quality of those experiences was the variable most strongly linked to girl's participation in science and mathematics.

Each STME clinic session is usually started with a pre-clinic survey using a set of questionnaires for participants to complete. The survey is meant to unearth misconceptions held by girls about science and science-related disciplines. Information gathered from these surveys year after year reveal that girls generally have negative attitudes towards science and science related disciplines, and that outmoded misconceptions and stereotyped attitudes are the major factors contributing to the negative attitudes among girls (Quashie, 1998).

Analyses of selected items of interest in both the SASI and MASI could help give further insight into the attitude of the STME and non-STME girls. Analysis of selected items of interest in the SASI and MASI are shown in Table 6 and Table 7 respectively.

A close look at Table 6 and Table 7 shows that for each of the 11 items, STME girls scored a higher mean compared to their non-STME colleagues.

A greater percentage of the STME girls also provided more positive responses for each item. For instance, for the statement "Science is one of my best subjects", 42.9% of those who strongly disagreed with the statement were STME girls compared to 57.1% who were non-STME girls. Also for the second item "Understanding science is very difficult for me", which is a negative statement, 30.4% of those who strongly agreed were STME girls whilst 69.6% were non-STME girls. Responses to other items were not different. Whereas only 25.0% of those who responded "strongly disagree" to the positive statement "I have decided to pursue pure mathematics at the SSS" (item 7) were STME girls, the remaining 75.0% of those who responded this way were non-STME girls. Similarly, majority (80.8%) of those who responded negatively to the statement "Boys are naturally better than girls in mathematics" were non-STME girls.

The fact that STME girls scored higher than their non -STME counterparts on the items could be attributed to the effect of the STME clinic on the girls who attended. The STME clinic is usually designed to encourage girls to take up science and mathematics subjects, do well in them and stay with them. Therefore activities during the clinic are always selected to ensure that at the end of the clinic session the participants may have been exposed to a scientific environment which can enable them begin to develop positive attitudes towards science technology and mathematics. The clinic may have helped the participants to get over traditional misconceptions about science mathematics and technology and hence the improved attitudes towards these disciplines compared to the non-participants of the clinic.

Table 6

Mean Scores and Percentage Distribution of Responses for selected SASI Items (N = 223)

Item	Group	SA	A	D	SD	Mean
1. Science is one of my best	STME	56.3	39.7	23.1	42.9	3.50
subjects	NSTME	43.7	60.3	76.9	57.1	3.18
2. Understanding science is very	STME	30.4	38.3	47.3	54.4	3.11
difficult for me	NSTME	69.6	61.7	52.7	45.6	2.79
3. Science is generally hard for	STME	28.6	29.5	48.4	61.3	3.16
girls	NSTME	71.4	70.5	51.6	38.7	2.58
4. I feel I am capable of doing	STME	59.8	44.4	25.8	11.1	3.48
science beyond SSS	NSTME	40.2	55.6	74.2	88.9	2.88
5. I can get good grades in science	STME	50.9	45.8	33.3	16.7	3.45
	NSTME	49.1	54.2	66.7	83.3	3.23
6. I am not good in science	STME	21.7	31.4	41.8	60.2	3.37
	NST E	78.3	68.6	58.2	39.8	2.83

Qualitative Analysis

An interview was conducted on selected girls to delve further into their attitude towards science and mathematics.

The interview sought the views of the girls on:

1. their knowledge and experiences during the STME Clinic.
2. changes in the girls resulting from the STME Clinic.

3. whether the girls have chosen to pursue science at the SSS or not and the likely reasons for each of these choices.
4. how the girls feel about science and mathematics as male domains.
5. their choice of career and likely reasons for their choices.

The ten schools from which respondents were chosen for the interview were lettered A to J before the interview.

Table 7

Mean Scores and Percentage Distribution of Responses for selected MASI Items (N = 223)

Item	Group	SA	A	D	SD	Mean
7. I have decided to pursue pure	STME	53.9	48.8	30.6	25.0	3.28
Mathematics at the SSS	NSTME	46.1	51.2	69.4	75.0	2.93
8. Boys are naturally better than girls	STME	19.2	48.4	47.4	52.3	3.20
in mathematics	NSTME	80.8	51.6	52.6	47.7	2.87
9. Girls who do elective mathematics	STME	22.2	32.0	40.4	57.1	3.47
at the SSS are likely to fail	NSTME	77.8	68.0	59.6	42.9	2.93
10. I am sure my grade in maths will	STME	50.0	52.9	32.4	28.6	3.16
be better than other subjects	NSTME	50.0	47.1	67.6	71.4	2.88
11. I feel no matter how serious I	STME	31.7	30.6	53.3	54.7	3.10
become I can't do well in maths	NSTME	68.3	69.4	46.7	45.3	2.65

Familiarity with STME and effect of STME on Respondents

The responses showed that all the STME girls but only three of the non-STME girls were familiar with the term STME and knew what it was about.

They indicated that STME concerns the learning of science and mathematics. They added that a group of girls attend a course annually where different people talk to them about the importance of science and technology. The STME girls in particular were able to state that the girls who attend the clinic each year are made to visit places where scientific activities take place. One of the STME girls responded this way,

> Yes, I have heard of STME before. I heard of it when I attended it at Bawku Secondary School during my form one time. STME means Science, Technology and Mathematics Education. It is usually organized for girls to tell them some important things concerning science and mathematics. Different people always come and talk about the importance of science and why we should do science at the JSS and SSS. (STME girl, School B)

The positive effect of the STME on the girls was evident. A good number of girls mentioned the computers they saw during an excursion to a computer laboratory. They indicated their surprise at the wonderful things that the computer could perform such as storage of volumes of information and the production of music. An STME girl's response was typical of the views of the girls,

> I learnt about so many science equipment and their uses when we visited the Bawku Secondary School Science Laboratory. I learnt some of the parts of the computer. The

> man in charge of the computer laboratory explained many things which the computer can do. He put it on and typed in some information and printed it out for us to see. I was surprised because the computer asks questions like ‘do you want to save the information’? In fact I enjoyed the course. (STME girl, School G)

Another girl said:

> we learnt how to make local soap. My group made local soap, but others also made some other things like door bells, fan and others. They explained how to make these to us. (STME girl, School J)

There was an indication of disappointment among girls who had not attended the STME Clinic. Majority of the STME girls (75.0%), said they wished they also had the opportunity to attend the Clinic, but since they didn’t get such an opportunity they felt they had missed something good.

The general pattern of the responses somewhat suggested that there was a change of feeling about science and mathematics among the STME girls. About 71.4% of them indicated that before they attended the clinic, they did not have any special feeling for these subjects, but after the Clinic, they had developed special liking for these subjects. One girl said

> Yes, the time I didn’t attend the clinic I thought science and mathematics will be too difficult for me at the SSS, but now I like these subjects especially mathematics. I now get

> high marks in it because I learn it more than before. (STME girl, School B)

Another girl also responded this way

> I didn't make my mind to do science because I was thinking that it is hard and I cannot pass it at the SSS, but after the Clinic, I decided to learn it more and now it is my best subject. I am sure I will get a very good grade in it. (STME girl, School G)

Reasons for choosing to pursue science at the SSS Level among STME and Non-STME JSS3 Girls

Interviews with 28 STME and non-STME girls show that those who expressed their desire to pursue the science programme if they had admission into SSS were mostly STME girls. Of the 14 STME girls, only one girl indicated that she will not pursue science should she be admitted into SSS. She said she did not choose the science programme when they were given the forms to indicate the schools and programmes they preferred. Only three of the non-STME girls said they will pursue science. A non-STME girl said

> I will not do science at the SSS. I have seen that my performance in science and mathematics are not all that good. I want to pass my exams in the SSS so I chose Arts". (non-STME girl, School G).

Different reasons were given by the STME girls for choosing to pursue science at the SSS. The responses suggest that interest in science resulting from exposure to the nature of science and the opportunities that science can offer, were to a large extent influential in determining whether the girls prefer to pursue science or not at the SSS. For instance, some STME girls said they preferred science because they like science, their performance in science was good and that they knew that science could help them in future. One of the STME girls said;

> Well, it is a very interesting subject because looking at our daily activities you will see that it involves science because through how we talk the way we walk every thing in our environment. With the help of science the world has become a global village and I strongly believe that science can help me earn a living. (STME girl, School B).

Another STME girl said;

> Because science at times deals with our by the nature of the environment in which we live and I wish to know much about myself, the environment and the useful things around us" (STME girl, School C).

One other STME girl indicated;

> Science, I see science to cover all the other subjects and if you have little idea in it, it will help you in future. (STME girl, School A).

In addition to their interest in science, some STME girls mentioned good performance as a reason for choosing science for SSS. An STME girl put it this way:

> The reason is that I now like science and maths and I do well in science and maths than other subjects" (STME girl, School B).

Another girl also said

> Yes I will do science. I look at my marks in science to be good so I decided to choose science (STME girl, School C).

The principal reason given by non-STME girls to explain why they will not pursue science in the SSS was however, poor performance in science and mathematics. They said they were not good in science and mathematics and therefore did not consider pursuing science in the SSS since that would not help them to pass. A non-STME girl answered this way;

> I am not good in science. The science course too you have to be good in maths but I don't like maths". (non-STME girl, School C). Another girl said

> I am not good in science, I don't get good marks so I cannot pass science. (Non-STME girl, School B).

The responses given by the STME girls compared with non-STME girls suggests that the STME girls were well informed about the disciplines of science and mathematics than their colleague non-STME girls. This could be attributed to the exposure of the STME girls to the STME clinic, thus suggesting that the STME clinic had been effective and indeed helped the STME girls to develop positive attitudes towards science and mathematics. This was further confirmed by responses of STME girls when they were asked to tell the experiences they gained from the clinic and whether the STME clinic had helped to change their feelings about science and mathematics. For example, an STME girl responded this way;

> I didn't like maths and science before the clinic but now I have more interest in these subjects. (STME girl, School B).

When further asked what she thought could have been responsible for the change in feeling towards the subjects, she said;

> The things they advised us about during the clinic make me have interest for these subjects. They let us to know that girls can pass maths and science even more than boys. They also told us that science and maths are good for girls because when you learn them you get job faster than boys (STME girl, School A)

Another response from an STME girl was this;

> Yes it changed. First I said I was thinking that mathematics was too difficult and as a girl the best thing for me is English that is General Arts but when I got to the science clinic, through the aspects of science that is Biology, chemistry and physics they have taken us through I have come to realize that it is very easy and that mathematics wasn't anything difficult. It is just that you

need a little time to sit down and learn and you can make it (STME girl, School B).

A girl in school H also gave the following response to a question on how the STME clinic had changed her feeling about science and mathematics;

"First I was afraid of maths but now I am not afraid of maths and science again".

These responses and similar ones clearly suggest that the STME clinics have made some impact on the participants. This supports the finding that there is a significant difference in the attitudes of STME and non-STME girls towards both mathematics and science.

There were varied responses to the question on which two subjects the respondents liked best. All the STME girls indicated interest in science, mathematics or Agricultural science. About 57.0% of the STME girls expressed interest in mathematics and science. The rest either said they liked mathematics and Agricultural science or General science and Agricultural science. On the other hand only two of the non-STME girls, expressed interest in science and mathematics. The rest said they liked other subjects such as social studies, English, or religious and moral education.

On the subjects they dislike, 64.3% of the STME girls mentioned both pre-technical skills and pre-vocational skills. The rest of the STME girls named either pre-technical skills or pre-vocational skills. Only three non-STME girls named mathematics and science as subjects they dislike. The rest mentioned pre-technical skills or pre-vocational skills with mathematics, science, Agricultural science, English language or social studies.

The choices of this smaller group of STME and non-STME students contradict what emerged when the girls were asked to choose a programme for SSS. The choice of programme did not show much difference between STME and non-STME girls compared to the choice of subjects. The choice of subjects revealed that whereas more STME girls prefer science related subjects, their non-STME colleagues prefer non-science related subjects. Perhaps the STME girls' preference for science related subjects may not necessarily be followed by pursuing the science programme at the SSS.

The dislike for pre-technical and pre-vocational skills was very common among both STME and non-STME girls. Almost every girl, whether STME or non-STME named at least one of these subjects as a subject she did not like. This agrees with the quantitative data on choice of programme for SSS which revealed that the number of girls from both STME and non-STME groups who chose pre-technical and pre-vocational skills was very negligible.

Preferred Future Job among STME and non-STME JSS3 Girls

When the girls were asked whether there were available jobs after school if one reads science and mathematics, all of them answered yes. Almost every girl mentioned Doctor (medical practice) and Nursing. These two professions run through almost every girl's response. Other careers which were mentioned were Agriculture, Piloting, Engineering, Accounting, Teaching, Pharmacy and

Meteorology. The STME girls mentioned more science-based careers than their non-STME colleagues.

The girls were further asked to name the job they wish to do in future. Nine STME girls said they wanted to become Doctors or Nurses in future, two chose Accountancy, another two chose teaching and one chose Journalism. Five of the non-STME girls chose Nursing. However, none of the non-STME girls chose the medical profession. Two of them chose Journalism, another two chose Accountancy and three chose Teaching whilst one each chose to be a Pilot and a Caterer.

The qualitative data have shown some slight difference in the choice of preferred career among STME and non-STME JSS3 girls. Majority of the STME girls preferred the Medical profession or Nursing compared to their non-STME colleagues, thus confirming what emerged during the quantitative data analysis.

There were also different reasons given for the various professions chosen. The reasons given by STME girls for wanting to be doctors appeared to be influenced by information gathered from the STME clinic. This response was typical of the responses:

> I took the decision because I admired the girls who spoke to us at the STME clinic. Three girls spoke to us. They made us to know that girls can do well like boy. Shiela Bawa was reading doctor course, Fatimah Awini was doing Laboratory course and Barchisu Aluma was doing Mathematics at University. (STME girl, School G)

Another STME girl answered this way;

> You see I have much encouragement from the STME. The way they took us on the importance of science make me to think that I should become a doctor or a nurse that is why I have chosen this job. (STME girl, School B)

The non-STME girls on the other hand, gave different reasons for their choices. A non-STME girl said;

> When people are sick, I feel pity for them so I want to help treat them (Non -STME girl, School E).

A greater number of the non-STME girls chose nursing as a preferred future career compared to the other careers. Among the reasons that influenced their choices were their love for the job of a nurse, their admiration for nurses and the attractive nature of the nursing career. About 60% of the non-STME girls indicated that they chose the nursing career for the fact that they love the job of a nurse. A Non-STME girl provided the following response:

> I chose nursing because I like the work of a nurse. The nurse is very caring and helpful. It is difficult to take care of sick people but nurses get time and patience to care for them. They bath and dress sick people who do not have relatives to care for them. At times some relatives of do not want to touch sick people because they fear getting the same disease, but nurses have time to care for them.

> Nurses are very kind and helpful. (Non-STME girl, school I)

Another non-STME girl said;

> Whenever I go to the Hospital, I always pity the sick people. Some of them are too sick that if you don't get the kind of training a nurse has, you will be afraid to touch them. I like helping sick people that is why I want to be a nurse so that I can help sick people always. (Non-STME girl, school D).

Some girls also said they admire nurse when they see them in their uniforms. Whereas some said they like the green uniform others said they admire the white uniform. There were others who said they admire the white hat worn by nurses. A non-STME girl put it this way:

> I stay in the same house with two nurses. I always like to see them dress and go to work. One wears a green uniform and the other wears a white uniform. I admire their uniforms and I want to become a nurse in future.(Non-STME girl, school F)

Some non-STME girls indicated that they chose nursing as a career because they feel they can work in any hospital due to the scarcity of nurses in the country. They said due to the scarcity, nurses are well paid as a form of encouragement for them to remain in the job. This response by a non-STME girl is typical of the responses:

You see nurses are not many like other workers like teachers. Every Hospital likes more nurses to come to them and work. A nurse too can work in more than one Hospital and get more money. Many Hospitals that are opened by people want nurses to work for them. Nurses can make much money if they are hard working. (No-STME girl, school C).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

In 1972 the Commonwealth Schools Commission in a report the existence of sexism and its negative influences on mathematics and science education of girls in some parts of the world.

In 1987, the Ghana Education Service (GES) realized that society had generally developed some negative attitudes, perceptions and misconceptions about girls' participation in science, technology and mathematics (STM), and that these attitudes were also influencing girls to develop negative attitudes towards the study of STM. To help address these negative attitudes, GES instituted the Science, Technology and Mathematics Education (STME) clinic for girls. Since then the STME clinics have been organized on annual basis with funding initially from the commonwealth secretariat, the VALCO fund and UNESCO. The programme later attracted funding from other organizations such as the Volta River Authority, the Bank of Ghana, Ghana Commercial Bank, Unilever Ghana limited, World Vision and the District Assemblies. Indeed, pretest items usually administered to girls before the start of each clinic session confirmed negative attitudes towards STM among the girls.

Despite claims by different individuals and groups including the GEU that the clinics were impacting positively on participants leading to positive attitude of girls towards STM, no independent study had been conducted on the attitudes of girls towards STM.

This study investigated the attitude towards science and mathematics among female participants and non-participants of the STME clinics. The study among other things sought to find out if there were any significant differences between the attitude of STME and non-STME JSS 3 girls towards science and mathematics. The study was also to find out reasons for which STME and non-SMTE JSS3 girls choose to pursue a science programme at the Secondary School level. A total of 223 JSS3 girls were selected for the study. These were made up of 103 STME and 120 non-STME girls. The girls were selected through a simple random sampling technique.

Three instruments were used to collect data from the selected sample. There were two attitude scale instruments and a semi-structured interview guide. A Science Attitude Scale Instrument (SASI) and a Mathematics Attitude Scale Instrument (MASI) made up of 34 items each were administered to the selected sample. The semi-structured interview guide was however used on a group of 28 girls who were further selected from the sample.

The SASI and MASI were each used to collect data on the attitude of the selected girls towards science and mathematics. Each scale contained a set of attitude statements to which each girl responded. The SASI had an equal number of statements which connoted positive attitude and those that indicated negative attitude towards science. This was also the case for the MASI. The responses to the statements were analysed quantitatively to determine the general attitudinal pattern of the girls. The semi-structured interview guide was used to collect data from a group of 28 girls selected from the sample for the study. There was a one-on-one interview with these girls to further explore their attitude towards science and mathematics. The data gathered through this method was analysed qualitatively.

Summary of Key Findings

1. Differences were found between STME and non-STME girls in their choice of science-based and non-science-based careers. A greater percentage of STME girls (63.1%) compared to 44.2% of their non-STME counterparts preferred science-based careers.
2. There were also differences between STME girls and their non-STME counterparts in their choice of preferred programme of study for SSS. Whereas 45.6% of STME girls preferred to pursue the sciences if they got admitted into the SSS, only 30.1% of their non-STME counterparts had a similar preference.
3. Interest in science, good performance in science, and knowledge of the opportunities offered by science were found to be influential in determining whether girls will choose to pursue science at the SSS. Also, poor performance in science and mathematics were largely responsible for the decision of non-STME girls not willing to pursue the General Science programme if admitted to the SSS.

4. There was a significant difference in the attitude towards science between STME girls (M = 114.3, SD = 13.8) and NSTME girls [M = 102.8, SD = 14.4; t (221) = 6.07, p = .001]. The effect size of the difference was moderately weak, r = 0.38. The eta square index indicated that 14% of the variance of the attitude towards science was accounted for by whether a student had attended STME or not.
5. There was a significant difference in the attitude towards mathematics between STME girls (M = 110.6, SD = 14.1), and non-STME girls [M = 102.2, SD = 14.9; t (221) = 4.26, p =.001]. The effect size of the difference was weak, r = 0.28. The eta square index indicated that 7% of the variance of the attitude towards mathematics was accounted for by whether a student had attended STME or not.

Conclusion

From the findings of this study the attitude of girls towards science and mathematics appear to be generally quite positive. However, STME girls' attitude towards science and mathematics was significantly higher than those of their non-STME counterparts. A greater percentage of STME girls compared to their non-STME colleagues were likely to enroll for General Science programme at the SSS level. On career choice, more STME girls were likely to pursue science-based careers than non-STME girls.

The factors that were generally found likely to be influential in determining if girls will pursue a science-related programme at the SSS level or pursue a science-based career in future indicate that STME girls are more positive in their attitude towards science related disciplines than their non-STME counterparts. Clearly, the Girls' Education Unit (GEU) and other political heads may have been right in their claim that the STME clinics were having a positive impact on girls in terms of their development of a healthy scientific culture and a positive attitude towards science and science related disciplines.

Recommendations

The following recommendations are offered to address the poor attitudes of JSS girls towards science and mathematics:

1. Considering the findings of the study, it is recommended that the science technology and mathematics education (STME) clinics should be expanded to cover all JSS girls instead of the current practice where only selected girls attend the clinic. This will help expose the girls to the science based activities that usually characterize the STME clinics and thereby make them develop positive attitude towards science and mathematics.
2. It is also recommended that mathematics and science teachers at the JSS level should make their lessons more practical and interesting. This will help girls to develop interest in science and mathematics in order to improve upon their performance in these subjects. This will influence the girls to choose to peruse science programmes when they gain admission into the SSS.

Areas for Further Research

The study investigated the attitude towards science and mathematics among girls who attended the STME clinic and those who did not attend. An evaluation of the STME clinic since its inception in 1987 should be embarked upon. This will provide comprehensive information on its impact on the attendants and justify its continued organization or otherwise. It will also help donor organizations to make decisions regarding their support to the organization of the STME clinics.

Findings of this study indicate that 45.6% of the STME girls compared to 30.0% of their non-STME counterparts chose to pursue the science programme if they got admitted into the SSS. It is important to conduct a tracer study at the SSS level to find out if these girls who indicated their desire to pursue science upon admission into the SSS really do so.

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APPENDIX A

MATHEMATICS ATTITUDE SCALE FOR JSS3 GIRLS

This is a master of Philosophy (Basic Education) study aimed at finding out how girls feel about Science and mathematics. The study is purely an academic exercise and respondents are assured of complete anonymity since all information given will be treated with the utmost level of confidentiality. Respondents are therefore advised to respond to the questions as candidly as possible.

1. What is the name of your School?………………………………………
2. Age:...……
3. What job do you want to do in future……………………….................
4. What do you want to do after JSS? I want to go to **(Please tick only one)**:

   SSS [ ] Technical school [ ] Vocational school [ ] Learn a trade [ ]
5. Tick the programme you have chosen to do at the SSS: Science [ ]

   General Arts [ ] Agriculture [ ] Business [ ] Vocational [ ]

   Technical [ ]

Instructions: This questionnaire contains many statements and you must respond to ALL of them. There are no "right" or "wrong" responses. The only correct responses are those that are true *for you*. Tick the appropriate column corresponding how you feel. Be sure to give a response to each statement. If you change your mind about any response, just cross it out and tick another. Some statements in this questionnaire are fairly similar to other statements. Don’t worry about this. Simply give your opinion about all statements. *Remember that you are being asked to respond by ticking Strongly Agree, Agree, Disagree, Strongly Disagree to each of the statements.*

		Strongly Agree	Agree	Disagree	Strongly Disagree
1	I am sure that I can learn mathematics.				
2	I have decided to pursue pure mathematics in the SSS				
3	Knowing mathematics will help me earn a living				
4	Mathematics will not be important to me in my life's work				
5	Boys are naturally better than girls in mathematics				
6	I enjoy the mathematics period than any other period on the time table				
7	Mathematics is difficult for me				
8	It is hard to believe that a girl could be very good in mathematics				
9	When a girl has to solve a mathematics problem, she should ask a boy for help				
10	I am sure of myself when I do mathematics				
11	I don't expect to use much mathematics when I get out of school				
12	Girls can do just as well as boys in mathematics.				
13	Girls who do elective mathematics at the SSS are likely to fail in it				
14	Mathematics is a useful and necessary subject				
15	I would have more faith in the answer for a math problem solved by a male teacher than a female teacher				
16	I am not the type to do well in mathematics				
17	I am sure my grade in mathematics will be better than other subjects in the BECE				

		Strongly Agree	Agree	Disagree	Strongly Disagree
18	Taking mathematics is a waste of time				
19	I find it very difficult learning mathematics				
20	Girls who enjoy studying mathematics are strange				
21	I feel I am capable of doing mathematics beyond SSS				
22	I feel doing mathematics in secondary school will be a waste of time for me				
23	I will use mathematics in many ways when I become an adult				
24	I feel no matter how serious I become, I can't do well in mathematics.				
25	Girls certainly are smart enough to do well in mathematics.				
26	I can handle most subjects well, but I just can't do the same in mathematics.				
27	I can get a good grade in mathematics at BECE				
28	I will need mathematics for my future work				
29	Studying mathematics is just as good for girls as for boys				
30	Doing well in mathematics is not important for my future				
31	My class boys would not take me seriously if I told them I was interested in careers in mathematics.				
32	I am good in mathematics.				
33	I study mathematics because I know how useful it is.				
34	I believe my performance in mathematics can be improved.				

APPENDIX B

SCIENCE ATTITUDE SCALE FOR JSS3 GIRLS

This is a master of Philosophy study aimed at finding out how girls feel about science and mathematics. The study is purely an academic exercise and respondents are assured of complete anonymity since all information given will be treated with the utmost level of confidentiality. Respondents are therefore advised to respond to the questions as candidly as possible.

1. What is the name of your School?………………………………………
2. Age:...……
3. What job do you want to do in future……………………….................
4. What do you want to do after JSS? I want to go to **(Please tick only one)**:
   SSS [ ] Technical school [ ] Vocational school [ ] Learn a trade [ ]
5. Tick the programme you have chosen to do at the SSS: Science [ ]
   General Arts [ ] Agriculture [ ] Business [ ] Vocational [ ]
   Technical [ ]

Instructions: This questionnaire contains many statements and you must respond to **ALL** of them. There are no "right" or "wrong" responses. The only correct responses are those that are true *for you*. Tick the appropriate column corresponding how you feel. Be sure to give a response to each statement. If you change your mind about any response, just cross it out and tick another. Some statements in this questionnaire are fairly similar to other statements. Don’t worry about this. Simply give your opinion about all statements. *Remember that you are* *being asked to respond by ticking Strongly Agree, Agree, Disagree, Strongly Disagree to each of the statements.*

		Strongly Agree	Agree	Disagree	Strongly Disagree
1	I am sure that I can learn science.				
2	Science is one of my best subjects				
3	Knowing science will help me earn a living in future.				
4	I don't think I can do science beyond the SSS.				
5	Science will not be important to me in my life's work				
6	Boys are naturally better than girls in science.				
7	Understanding Science is very difficult for me.				
8	Science is generally hard for girls				
9	It is hard to believe that a girl could be brilliant in science.				
10	When a girl has to solve a science problem, she should ask a boy for help.				
11	I am sure of myself when I do science.				
12	I expect to use much science when I get out of school.				
13	Girls can do just as well as boys in science.				
14	It is hard for a lady to get a job when she reads science.				
15	I would have more faith in the answer for a science problem solved by a boy than a girl				
16	I am not the type to do well in science				
17	I always like reading more science than other subjects.				
18	Taking science is a waste of time				
19	Science has been my worst subject.				
20	Girls who enjoy studying science are strange.				

		Strongly Agree	Agree	Disagree	Strongly Disagree
21	I feel I am capable of doing science beyond SSS				
22	I will use science in many ways when I become an adult				
23	Girls are as good as boys in science				
24	Girls can perform better in science than boys.				
25	Women certainly are smart enough to do well in science.				
26	Most subjects I can handle well, but I just can't perform well in science				
27	I can get good grades in science				
28	Science is one of the most important subjects in our daily lives, so we need to pursue it at the SSS.				
29	If science were not compulsory at the JSS, I would not have done it.				
30	Studying science is just as good for boys as for girls.				
31	I am not good in science.				
32	I study science because I know how useful it is				
33	My performance in science has made me feel I have the ability to do science beyond SSS				
34	I would trust a woman just as much as I would trust a man to solve important science problems				

APPENDIX C

INTERVIEW SHEDULE FOR STME AND NON-STME JSS3 GIRLS

This is a master of Philosophy (Basic Education) study aimed at finding out how girls feel about Science and mathematics. The study is purely an academic exercise and respondents are assured of complete anonymity since all information given will be treated with the utmost level of confidentiality. Respondents are therefore advised to respond to the questions as candidly as possible.

1. What is the name of your School?
2. Have you heard about STME? When was this? What is STME about?
3. Have you ever attended the STME Clinic? If yes, tell me the experiences you gained from the clinic. If you did not attend, do you think you missed something good?
4. If you attended the STME Clinic, did your feeling about Science and mathematics change? In what way did it change?
5. Tell me about the subjects you learn in school. Which two do you like best? Which two subjects do you not like at all? Give reasons why you like or dislike the subject(s).
6. (a) Will you pursue a Science programme when you gain admission into the SSS? What are the reasons for your choice?

   (b) Who made this choice for you?
7. Do you think Science and Mathematics are equally important for both boys and girls? Give reasons for your answer.

8. Are there available jobs that one can get after school if one reads Science and or Mathematics? What are some of these jobs?

9. With good grades in SSSCE what are some of the courses or programmes that a student can pursue in higher institutions of learning? Which of these courses are good for boys, and which are good for girls? Why?

10. (a) What job will you like to do in future?

    (b) Why do you like this job?

11. What made you decide on this job?

12. Are any of your parents or family members doing this job? If yes who?