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# WOMEN IN SCIENCE AND TECHNOLOGY IN GHANA: WHY SO FEW?

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## ABSTRACT

This study represents an attempt to identify some of the causes for the under-representation of Ghanaian women in science and technology related careers. The study identifies some internal characteristics (interests and ability) and social factors that differentiate female students who enter male-dominated career programs in the universities from those who do not. Eighty-five arts and humanities students and ninety-six science students enrolled in three universities in Ghana (the University of Ghana, the University of Cape Coast, and the Kwame Nkrumah University of Science and Technology), were randomly selected to complete a self-administered questionnaire. Among the students in the arts and humanities programs, forty-six considered at one point in their educational career considered pursuing a science program, but never did. The study sought to determine whether parental schooling and occupational status had any influence on the educational and career choice of the daughter. The study also investigates whether co-educational schools and single-sex girls' schools differed in regard to promoting science career interests in students. Other school factors that might have played a role in students' choice of program that were investigated include the influence of teachers, peers and counselors, and the interests and ability of students to cope with science and math. Finally, the study examined whether marriage, parenthood and career conflict played any significant role in the choice of career programs for these women.

Based on qualitative and statistical analysis of the data, the study concludes that the socio-economic status of parents affects both university access and students' educational and career aspirations. The majority of the respondents have parents whose

educational and occupational status places them in the upper class of the Ghanaian society. This suggests that female university students came from a far less representative cross section of the Ghanaian society. However, even within the various sub-groups, significant differences were found with respect to parental educational and career backgrounds. Physical science and engineering students tended to have parents with higher education, with either one or both in a science based occupation. Science students generally differed from non-science students in the support and encouragement they perceive to have received from parents, especially mothers to pursue a science career. This parental support seems to have enhanced their interest in science and the perception of themselves to achieve. Science students also differed from students who only considered a science career in being given more encouragement by schoolteachers. This study also concludes that girls who attended all-girls' schools gained more confidence in their ability to study and achieve in science, with an increased likelihood of studying a science-related program in the university. However, these all-girls' schools tended to be exclusive, privileged and highly selective of their students.

The results of this study also reveals that these young women have both been expanding their career choices into areas previously dominated by men and rethinking their options in marriage and parenthood. All respondents indicate that they want to establish a career before settling down to parent children. The study also reveals that older students (those from the sixth form program), faced more conflict regarding careers, marriage and parenthood, because the early period of their career development coincided with their prime child bearing years.

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# CHAPTER 1

## INTRODUCTION

Over the past two decades there has been an increase in the amount of educational research to redress the problem of the under-representation of women and girls in education in sub-Saharan Africa. The period has witnessed research on such diverse topics as women's contribution to economic development (Browne and Barrett, 1991; World Bank, 1993), the effect of women's education on fertility (LeVine, 1980), and personal hygiene and infant mortality (World Bank, 1988; Duncan, 1989). A number of these studies have produced clear evidence of the educational inequality suffered by African women. This better understanding of the significance of educating women, both to the women themselves and to the nation has informed the educational policies of both international donor agencies and governments. However, these studies have done very little to unravel the factors that prevent women from participating in the educational enterprise. Due to donations from international donor agencies such as CIDA, UNESCO, World Bank and other non-governmental agencies (NGO's), this period has seen a marked improvement in the enrollment rates of females in schools, especially at the primary level across the continent (Kelly and Elliot, 1982; Beoku-Betts, 1998). Despite these gains, there are still serious gaps between men and women at the secondary and tertiary levels of education. In a study of the participation of women in tertiary education in Africa, Beoku-Betts (1998) notes that:

> These levels of education exhibit the greatest gender disparity in formal education in terms of enrollment, achievement, training in critical disciplines such as science and technology, and career mobility patterns (p.159).

According to the United Nations' 1995 report, by 1990, girls made up 47 percent of primary enrollment in sub-Saharan Africa, 33 percent of secondary students and only 4 percent of tertiary-level education.

Without good scholarly research and due regard to cultural and economic factors, the suggestion has been made that building more schools will encourage the enrollment of more girls into primary and secondary schools. Stromquist (1998) however points out that in Africa, the education of girls is "predicated on the value for domestic work. If the economic value of girls for domestic labor increases, as is likely in an economic crisis, fewer girls will be able to take advantage of the increased school offering" (p.38). The present economic crisis facing many African nations has vindicated this observation by Stromquist. Many countries have had to cut back on their educational budgets, and this has resulted not only in poor quality teaching and learning and inefficient management of the educational system and reduced students' achievement (Beoku-Betts, 1998; Stromquist, 1998), but also in many families pulling their children out of school. The negative consequences of these factors is felt more on the education of girls who are pushed, even at an early age, into petty trading to supplement the family income.

Bowing under pressure from international donor agencies like the World Bank and the International Monetary Fund, most African nations have had to cut back on educational funding and introduce users' fees at the secondary and tertiary level education. The effects of this policy of off-loading a greater portion of the educational cost on parents is that it will naturally force parents to decide which of their children will be given higher education. Such decisions can be expected, as Stromquist (1998) points out, "to be particularly detrimental to the education of women from low-income families,

who generally bear the brunt of domestic duties in the household" (p.38). It is therefore no wonder that despite the acknowledgement of the importance of tertiary-level education by all governments, the growth rate of post-secondary education has declined in the sub-Saharan region from 14.1 percent to 7.3 percent between the period 1970 to 1990 (Beoku-Betts, 1998; p.167). With women showing the lowest participation rate in any region of the world – 4 percent (UN, 1995).

There are a considerable number of studies on the education of women in the Western industrialized societies, which identify trends that can provide a useful basis for asking questions about educational patterns in Africa. Some of these trends are examined in this study. However it must be taken from the perspective that such studies can only be suggestive for Africa since cultural values, family structures and sex-role division of labor in the family differ from society to society (Kelly and Elliott, 1982).

Over the years, research from Europe and North America on the under-representation of women in science has often fallen into two categories. One category of studies focuses on the decision-making processes of women in the context of the psychology of women (Baker and Leary, 1995; Kelly, 1987; Volman et al., 1995). This approach seeks to locate the problem of the under-representation of women in science and math education on intrinsic characteristics of women. This psychological approach seems to be quite popular among researchers. But Kelly (1987) notes that results from this approach can be misinterpreted to mean that if women under-achieve in science courses then one can say that there must be something wrong with their perceptions of the subject, of the world or of themselves. This approach has led many policy makers to design intervention strategies to help girls correct their misconceptions of science and to

boost their confidence. In other words, "girls are expected to change to accommodate science" (Kelly, 1987; p.1).

The alternative approach seeks to locate the problem of female under-representation in factors in education (the school, or society at large) which must be challenged to accommodate girls (Volman et al, 1995). Most of the more recent studies however, take the perspective that psychological factors and factors within the society and school are responsible for the choices that women make in their educational and career paths (Kelly and Elliott, 1982; Volman et al., 1995). According to these research studies these choices do not depend only on inherent characteristics in the girl. Rather, they are the end product of a process, which involve sex-gender systems and the sexual division of labor. These studies thus deal with the role of the teacher, the socialization process of girls, the development of the girl's sense of femininity, subject matter and teaching methods, the relationship between school and societal characteristics and the student's career aspirations (Kelly, 1985; Volman et al, 1995). From this perspective it has been established that the educational and career choices an individual makes are linked to the individual's expectations for success and the importance or value the individual attaches to the various available options (Eccles, 1994). The individuals' expectation for success depends on their confidence (built over a period of time) in their intellectual abilities and on their estimation of how difficult or easy are the required subjects of the program to master. Likewise, the value of a particular educational or career choice to the individual is influenced by such factors as whether the person will enjoy studying for the program. Also, what is important is whether the program is seen as instrumental in meeting the individual's long- or short-term goals. And whether the

people who matter in the individual's life (for example, parents, teachers, counselors, and peers) approve or disapprove of the career program, encourage or discourage the individual.

Eccles (1994) believes that although individuals do choose from educational or career programs from among several options, they do not actively or consciously "consider the full range of objectively available options in making their selections" (p.589). Many options are never considered because the individual is unaware of their existence. Other options are not seriously considered because the individual has inaccurate information regarding either the option itself or the possibility of achieving the option. Still other options may not be seriously considered because they do not fit in well with the individual's gender schema (Eccles, 1994). For example, a girl who has been socialized into believing that science is a masculine subject is not going to consider it as an option when it comes to choosing a subject. Thus understanding the processes which influence an individual's perception of the field of viable educational or career options is essential to our understanding of why girls choose one field of study or the other. A number of studies have pointed out that women usually make decisions about occupational choices differently from men (Eccles, 1994; Baker and Leary, 1995; Rayman and Brett, 1995). These decisions arise from their expectations of multiple life roles, self-identity, and ways of interacting with people, objects and experiences in the world. For example parents, teachers, and peers and counselors can directly or indirectly influence a girl's choice of field of study. Parents, teachers and counselors can directly influence a girl's option for a science or non-science program by mandating, encouraging, ignoring or discouraging her from her preferred option. Peers influence

subject choice directly, according to Eccles (1994), by for example, making fun of a girl who openly expresses her desire to pursue a career in science. Indirectly, girls are made to consider their professional career in relation to their roles as mothers, wives or lovers (Eccles, 1994; Baker and Leary, 1995). Eccles (1994) concludes that when it comes to choices, social systems can either encourage or discourage an individual from considering gender role stereotypic choices. Unfortunately, in most cases these social systems operate in such a way that those individuals are most likely to consider options that are most consistent with their gender role schema. Many previous researches on women's education and its outcome have ignored this sex-gender system, which consign women to narrowly defined roles. Such studies have merely outlined the differences in educational outcomes for men and women. Kelly and Elliott (1982) point out that most of these studies do not explain how these differences are generated. "Scholarship of this sort can provide little basis for reforming schools, nor can it tell us what impact education has on women, even if that impact is different from that of men" (p.3).

I locate my study in the perspective of those who believe that both psychological and social factors combine to influence the very ability of women to obtain the type of education schools offer to women who attend. For a woman's education will be affected by how ethnicity, social class, and rural/urban factors interact to predict her response to schooling, either in the kind of school she attends, how she accepts both social and school-legitimated knowledge about what she can and cannot do, and the use to which she believes she can put her knowledge.

## 1.1 Theoretical Perspective

Most research on the under-education of women in Africa, sparse as it may be, has focused on comparisons between the performance and outcomes of male and female education. The primary objective of these studies has been focused on the availability of educational opportunities and how educated women respond to the labor market. But as Kelly and Elliott (1982) note, understanding the patterns of women's education requires more than just analyzing data to detect sex differences along standard dimensions of analysis:

> Whether women will receive education may well depend on a host of factors other than the availability of educational opportunities. Women's education is also affected by whether girls and their families believe schools will better their lives, regardless of the complicity of schools in maintaining women in subservience to men (p. 4).

Also, the fact that women respond differently to the labor market than men do does not mean that education has little or no effect on women. For the participation of women in the labor market in Africa does not always arise as a result of education as it does for men. Research on the education of women must therefore endeavor to both, detect and challenge traditional beliefs and practices that keep women is such subservience, limit their freedom (both in private and public) and work against their democratic rights as citizens. This should include the examination of parental and societal expectation of an educated female and the processes within schools and classrooms. Research must show how the "dynamics of teacher-student interaction, the messages and images in textbooks, and several aspects of the "hidden curricula" produced negative and cumulative impact on the development of women's social identities" (Stromquist, 1998; p. 26). So far current research has failed to achieve this within the African context.

Based on inadequate research findings and incomplete disregard to the prevailing socio-cultural experiences of the majority of the people, international donor agencies (especially the World Bank and the International Monetary Fund which leads in the execution of educational projects in developing countries) offer solutions to the educational problems in Africa. For example, Stromquist (1998) cites a World Bank document entitled *Education in sub-Saharan Africa* (1988) which sees "the proven links between mothers' education and the health and educability of the children, and the connection between education and reduced fertility" (p. 35) as the reason for the education of women in Africa. According to Stromquist, among the solution the authors of this document proposed for gender equity in education were the establishment of small community-based schools, provision of free textbooks, charging of lower tuition fees, and charging families less for boarding and welfare services for girls than for boys. Experience has shown that when proposed solutions to educational reform do not recognize sex-gender systems that limit women to narrowly defined roles, it is doubtful whether these "solutions" work. Gender equity in education is not just a matter of good economics, nor being concerned with only the private sphere of marriage or reproduction, or better maternal care. It is also a matter of social justice. Therefore in this study, rather than asking the familiar questions which seek to compare the outcomes of education of males and females in Africa, I choose to ask how different provisions in society contribute to women's educational and occupational outcomes previous studies have identified. This perspective sees the outcome of the education of women in Africa as shaped more by social systems that place women in a subordinate position to men, rather than any psychological factors inherent in women. Hence any research that will act to

emancipate women must begin with women themselves. This is the approach that critical theory takes. As Acker and Oatley (1983) points out "the critical approach have the advantage of moving us away from the assumption that whatever men do is 'better' and that women need to learn how to emulate them" (p.266). Critical theory reveals the factors that prevent women from making a free career choice, how exploitive and repressive culture, society and the educational institution has been to women. This makes it possible for intervention strategies to be formulated.

In view of the perspective, which is guiding this study, I have chosen to use a sample of only women. This avoids the male standard of ideal achievement by which females' achievement must be judged.

The following section deals with how the European-style education has developed in Ghana and in a way helped maintain the subservient status of women in the Ghanaian society.

## 1.2 Education in Ghana

### 1.2.1 Background

Before the introduction of the European-type of schools in what is now called Ghana, the most common and dominant method of transmitting knowledge was through apprenticeship. By observing adult skills in such occupations as smiths, farming, fishing, hunting, mixing of herbal concoctions for curing diseases, drumming, etc. children learned how to carry on the family trade. Also, before significant stages in their lives, especially during the puberty rites for young adults (the transition point from youth to adulthood), intensive moral and ethical instructions from family and community elders

were given. The purpose of these special periods of formal instruction was to ensure that the individual would understand and be able to live up to what the community requires of him or her. This involved a good housekeeper, wife and mother for women; and for the men, a family provider (hunting, long-distance trading, farming, and fishing), and a defender of the community from external aggressors.

According to Foster (1965), the earliest European-type educational experiment in the Gold Coast was initiated by the Portuguese, who by 1482 had established a fort at Elmina. "In a series of instructions to the captain at Elmina in 1529, King Joao III advised his representatives to 'take special care to command that the sons of the Negroes living in the villages learn how to read and write, how to sing and pray while ministering in church'" (p.43).

A little over a century later, when the Dutch seized the Elmina Castle, they restarted the school in the Castle in 1644. In the following century the Danes established one (in 1727) at Christianborg in the present-day Accra (the capital of Ghana) and the English another (in 1751) at Cape Coast. One distinctive feature of these early educational practice was that it served mostly the children born through African and European unions, children of African traders and the children of some African chiefs.

While in most African countries, early educational enterprise was closely associated with the activities of organized missionary bodies; it was not the case in the Gold Coast. Education in the Gold Coast became, for a time, a subsidiary function of the great merchant companies, whose activities preceded the advent of real missionary endeavor by over one hundred years. "The schools suffered during its checkered early career not only from the general indifference of the natives, but also from the very

lukewarm support afforded by the merchant companies and their officials" (Foster, 1965; p. 44). Generally speaking, the curricula of these early schools were similar; reading, writing, arithmetic and the inevitable core of biblical instruction. By 1765 missionary activities, especially by Presbyterian and Methodist missions necessitated the opening of many schools. A board of education was set up in the 1880s to inspect schools that met government standards in order to qualify them for grants. Though a number of promising students of these early schools were sent to Europe for further studies, primary education was emphasized until limited secondary education was introduced in the early 1900s.

The real impetus to education in the Gold Coast was given by Governor Guggisberg's educational policy. In 1919 he announced his 10-year development plan in which he stressed his desire of replacing Europeans with educated Africans in many administrative positions throughout the country. In order to achieve this the plan stressed among other things "the need for improved teacher training, equal education for girls, a greater emphasis on vocational training, and the establishment of more secondary schools" (Owusu-Ansah, 1995. p 118). The 1930s and 1940s saw a phenomenal increase in the number of schools (both private – mostly by the missionaries – and public) being established. Whereas most parents in the northern regions of the country resisted the enrollment of their in schools, many in the south encouraged formal education because it was regarded as a guarantee of acquiring white-collar jobs and wage-earning positions.

In 1952, when Ghana had gained internal self-government, the Convention People's Party (CPP) –led government drew up the Accelerated Development Plan for Education. This program was designed to provide education for every Ghanaian child who was six years and above. To achieve this goal, the Central Government took

responsibility for the opening of new teacher training colleges and funded existing colleges through the Ministry of Education. Since then, a considerable portion of the country's budget had been spent on education (Owusu-Ansah, 1995).

## 1.3 Structure of the Educational System

### 1.3.1 Before the Reform of 1987.

Before the introduction of the educational reform of 1987, Ghana's educational system was made up of the elementary (6 years of primary and 4 years of middle), secondary and commercial schools, technical institutions, and teacher training colleges and universities. In addition to the majority of public schools that offer the 10 –year elementary program, there were also a few public and private 6-year primary schools that prepare students to enter secondary schools at the end of their sixth year. Students from the elementary schools could however be admitted to the secondary school anytime from grades 7 to10 upon successful passing of the national Common Entrance Examination.

With the traditional 10 years of elementary, seven years secondary (5 years preparation towards Ordinary Level Certificate and 2 years of Advanced Level studies) before entering degree-granting institutions, the vast majority of students enter first-year university after their 21$^{st}$ birthday.

### 1.3.2 The Reform of 1987

Due to overwhelming criticism of the structure of the educational system and "partly in keeping with the government's economic reform program" (Owusu-Ansah,

1995; p.121), reforms to the educational system were announced in 1987. The aim was to reduce the length of pre-university education and to make the curriculum more relevant to the socio-economic needs of the country. The 1987 reform, which had been experimented in some selected schools since 1979, admitted all 7th grade students (who would have gone on to first-year middle school) into the new junior secondary school (JSS) to begin a 3-year program of vocational, technical, and academic studies. From the JSS students would qualify to enter the senior secondary schools (SSS), upon successfully passing a national terminal examination. Students spend three years at the SSS to prepare to enter the universities, polytechnics, or the teacher training colleges.

## 1.4 Educational Financing

In the years between self-government in 1951 and the overthrow of the first democratically elected government in a coup in 1966, the Central Government eliminated tuition fees in all public schools – from primary to the university levels. At the same time a new system of paying salaries to teachers in training colleges went into effect to encourage more people into teaching in response to the overwhelming teacher demand due to the effects of the Accelerated Development Plan for Education. At the beginning of the 1963/64 school year, the government instituted a free textbook scheme under which basic textbooks (which formerly parents had to supply) were provided free in primary, middle and secondary schools. However subsequent governments since 1966 cancelled the free textbook scheme.

Though tuition is free at all levels of the public education system today, including the universities, students pay textbook fees at the primary, JSS and SSS. Boarding

students in secondary schools and technical institutions must pay boarding fees. Still at the teacher training colleges, students enjoy free boarding and textbook education in addition to being paid monthly salaries.

## 1.5 Girls' Education

The transition into the modern world has been slow for most Ghanaian women. "The high rate of female fertility in Ghana in the 1980s showed that women's primary role continued to be that of child-bearing" (Owusu-Ansah, 1995; p.101). The period 1850 to 1900 saw increased interest in girls' education in the then Gold Coast. Mrs. Grimmer (the wife of a Wesley missionary) opened a school for girls in Cape Coast in 1870. She used to meet them three days in a week at the Wesley Mission house, and gave them lessons in needlework. The need was also expressed for a Wesleyan boarding school where parents from the adjacent towns might send their daughters and where the girls would be entirely under the control of the Governors.

An advanced girls' school was opened in Cape Coast in 1874 with fourteen girls. The number soon increased to twenty. "Admission was opened to only girls who had been sufficiently long in the lower school to be able to speak, write and read English" (Graham, 1971; p.132). According to Graham (1971), the advanced girls' school was to be patterned to some extent on schools for middle class girls in England, where the "'accomplishments' were the accepted core of a girl's education. Performance on the piano or harp or drawing and painting were diligently practiced together with a host of ornamental skills which could be effectively performed, and where the girl was to be brought up almost solely to shine on the social occasion" (p.132). Needlework,

dressmaking, fancywork were thus among the subjects taught the girls in the colony. The need was felt that educated young men should be able to have wives who would match their educational attainments. According to Graham (1971), at that time even in England, marriage appeared to be the main goal to which girls were educated to aspire. He notes that "in 1890 in England, for instance, when grants for the 3Rs were abolished, the needlework, singing and cookery grants were continued" (p.132). In both England and the Gold Coast, therefore, girls' education seemed to have a rather specific and definite goal: that of marriage.

The Government of the Gold Coast Colony did not seem particularly anxious to give special place for girls' education. It was rather the missionaries who attempted to help forward girls' education. Current research (Oppong and Abu, 1987; Owusu-Ansah, 1995) supports the view that, notwithstanding the Education Act of 1960 which expanded and required compulsory elementary education for every Ghanaian child, some parents were reluctant to send their daughters to school because their labor was needed in the home and on the farm. Resistance to female education also stemmed from the conviction that their husbands would support women, even when they were educated. In some social circles, there was even the fear that a girl's marriage prospects dimmed when she became educated. Since 1960 there had been a phenomenal increase in the rate of enrollment of girls at both the primary and the secondary levels of education. In particular, during the last two decades the enrollment rate of girls in the primary levels has almost doubled and is almost at par with that of boys (fig1, UNESCO, 1998)

| Year | Total: M/F | Female | Percentage F |
|---|---|---|---|
| 1980/81 | 1 377 734 | 611 328 | 44 |

| | | | |
|---|---|---|---|
| 1985/86 | 1 505 819 | - | - |
| 1986/87 | 1 565 236 | 676 486 | 43 |
| 1990/91 | 1 945 422 | 879 430 | 45 |
| 1991/92 | 2 011 602 | 918 411 | 46 |

Though there had been a marked improvement of girls' enrollment in secondary school, it is not as remarkable as that in the primary school (fig 2, UNESCO, 1998).

| Year | Total: M/F | Female | Percentage F |
|---|---|---|---|
| 1980/81 | 693 159 | 263 097 | 38 |
| 1985/86 | 749 980 | - | - |
| 1989/90 | 829 518 | 323 931 | 39 |
| 1990/91 | | | |
| 1991/92 | | | |

Just as female enrollment in secondary education has been increasing, so is the awareness that they must be encouraged into previously male-dominated career programs. Thus, after the Commonwealth Secretariat regional workshop in Accra in 1987 on the theme "Gender Stereotyping in Science, Technology and Mathematics Education" (STME), the Ghana Education Service (GES) set up the 'Science Clinic' for girls. The name 'clinic' was used, according to the organizers,

> In analogy to a hospital situation, its aim was to diagnose and attempt to prescribe a course of therapy for an existing 'malaise', the low participation of girls in science, technology and mathematics education (GES, 1998).

The goal of these clinics, which has become an annual affair, is to increase the level of female students' participation and achievement in science and math, and to encourage them to choose science-related careers at the universities.

## 1.6 Choice of Subjects

In Ghana, all public and private elementary and secondary schools practically follow a common curriculum. This is due to the national terminal examinations that are used as a basis for transition to the secondary schools (for elementary students) and the universities or other post-secondary institutions. Before the introduction of the 1987 educational reform, students who entered the secondary schools followed a curriculum made up of a combination of general science, languages, arts and, depending on the kind of school, commercial subjects for the first three years. During this period every student was supposed to study all the subjects taught at this level. This is an attempt at exposing the students to as many subject disciplines as the school could offer so that they can identify their area of interest and ability.

At the end of the third year of secondary school, the student chooses the subjects he/she wants to present at the Ordinary Level Examination. The National Examinations Council requires a student to present a minimum combination of six and a maximum of nine subjects at the ordinary level examinations. The subjects chosen depend on the available options offered by the school. However, the options are made up of: (i) Sciences: physics, chemistry and biology; (ii) Arts: history, geography, religious studies, languages (usually French), literature in English, home economics; (iii) Commercial subjects: commerce, accounting, shorthand and typing, economics.

English and mathematics are compulsory subjects for all students irrespective of subject discipline. But if a student desires to study mathematics at the advanced level, he/she was required to take an additional mathematics course. Students who choose arts or commerce are required to study either general science or one major science subject (physics, chemistry or biology).

The choice of subjects depended, apart from the student's own interests and preferred future career, on his/her performance on that particular subject, especially at the end of the third year. However the criterion for performance is applied more often for those who desire to study the sciences. In some schools guidance teachers meet individually with students to assist them make their choices. Subject teachers also reserve the right to refuse to accept a student in their class if they can prove (using their own assessment criteria based on both the student's academic performance and general comportment in class) that the student would not be able to do well in that subject.

At the end of the fifth year, the students write the Ordinary Level Examinations. If the student gets the required grades and so desires it, he/she can apply to enter the sixth form to pursue a two-year advanced level study in preparation for the university. Like the ordinary level program the advanced level program consists of science, arts and commercial options. However, students are required to study only three subjects in addition to a compulsory general paper course. It is interesting to note that though a student may have done science at the ordinary level, he/she can decide to switch to arts or commerce at the advanced level, depending on his/her ordinary level subject combination and the grades obtained in those subjects. However, an arts or commerce student cannot opt for a science program at the advanced level. At the end of the two years of advanced

level studies students write another national qualifying examination for admission into the universities. In this case also it is possible for a science student to switch to take a program in the arts or the humanities at the university, whereas it is quite impossible for an arts student to opt for a science program.

With the present reformed educational system the manner of choice of subjects remains the same. The only difference now is that the choice of subjects is made before a student enters into the senior secondary school.

# CHAPTER 2

## REVIEW OF RELATED LITERATURE

A number of studies have been undertaken to find explanations for the under-representation of women in science careers. According to Leslie et al. (1998), a recent review of literature identified no less than 120 empirical and theoretical undertakings related directly to this issue. Diverse motives have driven research on this issue: projected shortage of scientific labor (for example, Seymour, 1995); equity and democratic issues (for example, Baker and Leary, 1995; Reid, 1997); and feminist critique of the history and epistemology of science (Rayman and Brett, 1995; Volman and Van Eck, 1995). Researchers have offered a number of hypotheses to explain why women are under-represented in science educational courses or careers. The next section reviews some of this literature.

### 2.1 The Genetic Deficit Model: Spatial Abilities

Some researchers have sought to explain the under-representation of girls in science and mathematics by alluding to an innate genetic difference between the sexes. This genetic deficit in females creates a natural inability to succeed. With reference to mathematics it has been suggested that girls take longer in their development to attain the Piagetian "formal operations stage," therefore their tendency to break problems into multiple stages may lead to an increased chance of error (Whyte, 1986). The most frequently cited biological cause for difference has been the possible existence of a spatial gene, which accounts for the male superiority in mathematics and science.

Definition of spatial ability range from such diverse tasks as locating a single figure within a complex figure to mentally rotating an object as rapidly as possible. Spatial visualization is usually measured by tasks such as matching a picture of a cube with the correct two-dimensional drawing of the unfolded cube. According to Gray (1981), the implications of these biological arguments are that it would be an exercise in futility to attempt to change this female inferiority, because one would be working against "natural inequalities of ability". The genetic deficit model has been criticized for not being adequately substantiated, drawing heavily on inferences from animals (Whyte, 1986), ignoring cases of women who have succeeded in traditionally male subjects. The model had also been criticized for giving too little attention to more general mathematical skills and to components of achievement other than ability such as motivation and anxiety (Kaminski,1981) and narrowly focusing on spatial abilities. Fennema and Sherman(1979) and Maccoby and Jacklin(1974) have concluded that gender differences in spatial abilities contribute to the gender differences in mathematics and science. Reyes and Padilla (1992) note that a difference favoring males in spatial visualization appears around middle school, about the same time that sex differences in math and science begin to appear. However, researchers do not agree as to the extent and nature of the differences in spatial abilities in science and mathematics achievement between boys and girls. According to Klein (1989), the majority of research indicates that spatial ability differences do not appear before age 14 or 15. Maccoby and Jacklin's (1974) conclusions that there were reliable gender differences in verbal, mathematical, and spatial abilities had been refined considerably by subsequent meta-analytic research (Hyde and McKinley, 1997) which indicates that there were no gender differences in verbal ability

except for better female performance on measures of speech production. In the case of mathematics performance, there are no gender differences in computation or in the understanding of mathematics concepts; however gender differences in problem solving appear in high school. This may be a result of the reduced enrollment of girls in optional mathematics. With respect to spatial ability the gender differences found vary markedly as a function of the type of ability that is assessed (Hyde and McKinley, 1997). A number of recent meta-analyses conclude that within the practical realm no evidence exists that differences in cognitive abilities exist between males and females and are responsible for the under-representation of women in the fields of mathematics and science, and even where they exist, they are small and have declined within the last two decades (Kimbell, 1982; Steinkamp and Maehr, 1983; Linn and Hyde, 1989; Caplan and Caplan, 1997). Thus the difference between male and female mathematics and science achievement and career representation must be located within some other contexts and situations. Available evidence does not suggest that women's lack of potential for achievement derive from any inherent deficiency. Rather, "developmental experiences and socialization of men and women determine the degree to which 'readiness to learn' is encouraged and expressed" (Fischer, 1982).

## 2.2 Sex Role Stereotypes

Stereotypes that label certain studies (mathematics, science and technical subjects) as masculine and those with domestic orientation, such as teaching (especially at the elementary level), nursing, home economics, typing, cookery, etc. or language based, as feminine have been cited by many studies as one of the causes of female under-

representation and achievement in science. Whereas it is rarely suggested that boys would not be able to succeed, should they decide to choose traditionally feminine subjects, it is frequently assumed that girls would be unable to handle traditionally masculine subjects (Whyte, 1986). These stereotypes, generated from the media, peer pressure, teachers, literature and other social agents, influence parents' expectations for their children and the students' expectation for themselves (Reyes and Padilla, 1992; Acher and Oatley, 1993). Duncan (quoted in Kotte, 1992) notes that students who saw science as a male domain commonly showed less positive attitudes toward science and therefore performed poorly. Kotte (1992) writes that while gender-typed attitudes apparently have an effect on achievement, and science subjects such as biology, chemistry, and physics are clearly gender-typed, the influence of their gender-typing process is not well understood.

Fischer (1982), however, notes that many children have no conception of the field of science or arts at the age of 6. However, as girls reach adolescence the view of science as masculine is most pronounced (Fischer, 1982; Klein, 1989). Moreover, their interests are already differentiated along expected lines, with girls drawn to biological and botanical topics and boys to those of physical science (Whyte, 1986). At this age, girls have the most intensified interest in sexual identity and the greatest need to conform to what they believe to be congruent to female sex-identity, a problem that is exacerbated whenever career-related choices must be made at such vulnerable age (Robertson, 1988). Thus, if these girls view science as a male domain, which conflicts with their femininity, they may not choose it as career courses. Fischer (1982) however, points out that attributes of these stereotypes may vary depending on the social class, educational environment in

which the child was raised, family structure, geographical location of habitation and the historical era in which the individual lives.

## 2.3 Female Role-Models

In recent years literature has emerged focusing on the importance of teachers, parents and significant adults acting as role models to the scientific career development of women. However the exact nature, extent and relative impact of these various models on different aspects of the career development process of girls remain unclear (Esposito and O'Halloran, 1989; p.165). The lack of female professional and occupational role models has been identified by some researchers as a significant barrier to women's career development in the sciences. While conversely, the availability of female role models has received support as an important positive influence (Erkut and Mokros, 1984). Other researchers have however found that before girls become old enough to be influenced by models of successful women scientists or engineers, they may have made up their minds already. For example, Fischer (1982) suggests that a young child is more inclined to emulate a child who is slightly older than him/herself and who is interested and involved in scientific activity; therefore any attempt to use role-models must be early (by grade 5), before the conflict is strong. In a study of 163 first year engineering students in Ontario universities in 1976, Ellis (1982) reports that before making the decision to study engineering, only two of the research participants had ever met a woman engineer. Three could recall the name of a woman engineer, not necessarily a Canadian, about whom they had read. None of the others had anyone who could be termed a same-sex role model for

the profession they were preparing to enter. Though Ellis admits that her research sample is small to make any generalized statement, it does confirm the work of other researchers.

## 2.4 Career Expectations

A number of studies suggest that parents and teachers have higher educational expectations for boys than for girls, though these biases do not emerge with any consistency until adolescent years (Meece et al., 1982). It is uncertain how these different expectations for boys and for girls are conveyed. There is undoubtedly a variety of direct and indirect means by which children learn what others expect of them, and a number of studies have shown that adolescents sort their occupational plans into clearly traditional routes (Allen, 1980) – boys opting for science and technology related programs and girls opting for the humanities and social sciences. Patterns of reinforcement, direct instruction, and evaluative feedback for children's mathematics and science performances are three means that have received recent attention (Kotte, 1992; Meece et al., 1982; Reyes and Padilla, 1992). For example, researchers have found that parents, teachers and counselors convey different expectations for boys and girls in their learning of mathematics and science (Ellis, 1982; Steinkamp and Maehr, 1983). These adults offer more explicit reward and reinforcement to boys than to girls; give different information regarding the importance of preparing to support oneself and one's family; give different information regarding the occupational opportunities that the student should be considering, and give different opportunities to develop their skills (Eccles, 1995). In addition, on the basis of extensive observation in classrooms, several studies have concluded that the quantity and type of teacher instructions varies according to the

sex of the student. In general these studies have found a disproportionate teacher time and attention between girls and boys, with the boys receiving more of the teacher's time and attention than the girls (Sadker, Sadker and Klein, 1991; Reyes and Padilla, 1992; Acker and Oatley, 1993). Many researchers agree that the quality of reinforcement given to the students by the classroom teacher (for example, praise, critical feed back, attention, etc) impacts more on students' attitude towards the subject than the issue of role models or the sex of the teacher (Monatelli and Hill, quoted in Fischer, 1982; Seymour, 1995).

According to Kotte (1992), substantial changes in many industrialized countries in the roles of women and their career expectations had occurred during the period 1970 to 1984. Girls and women are made aware of these societal changes during discussions at school and at home and through the media. Paralleled by greater encouragement from parents, peers, teachers, and often, improved employment opportunities, more girls are now opting for science-related careers. Kotte (1992) believes that if more women expressed an increased need for education and training in science-related professions during the last two decades, then it means that the educational and occupational opportunities offered by the educational system and labor market had changed (p. 31-32). But moreover, the expectations of girls and women also have undergone considerable changes at the same time.

## 2.5 Early Socialization

Social scientists agree that the attitudinal differences that are crucial for adolescent boys and girls to make appropriate educational and occupational choices are

the outcome of social learning processes acquired from childhood. The literature reveals that due to the different treatment of girls and boys, girls tend to place a lot of importance on relationships with others. Their connections with people around them and their responsibilities to these people play a far greater role in their lives than for boys (Kelly, 1979; Peltz, 1992). Girls' desire to win the approval of parents and teachers make them vulnerable to the control of these adults. This desire shifts the "source of personal satisfaction from task completion to external adult approval and may foster dependency and lack of self-confidence" (Fischer, 1982). Thus they are not likely to opt for science and mathematics courses, especially if these adults consider them inappropriate for girls who might already be finding these subjects difficult. According to Meece et al. (1982), in addition to the more direct socialization effects, parents and teachers can influence children's achievement behaviors, and values by the types of general experiences they offer or encourage. Differences in the kinds of play activities that boys and girls are encouraged to engage in suggest markedly different learning experiences for members of the two sexes. Toys and play frequently provide boys but not girls with pre-scientific and practical experiences of educational values (Steinkamp and Maehr, 1983). Jozefowicz et al. (quoted in Eccles, 1994) found in a longitudinal study of adolescent life transitions that girls placed more value than boys did on the importance of making occupational sacrifices for one's family. Girls also rated having a job that allows one to help others and do something worthwhile for society more highly than boys did. In contrast, the boys placed more value on becoming famous, making lots of money, seeking out challenging tasks, and doing work that involves the use of math and computers. The essence of gender roles, according to Eccles (1995), is that they define the activities one

should engage in in life in order to be successful in that role. If success in one's gender role is a central component of one's identity, then activities that fulfil this role should have high subjective task value and activities that hamper efforts at successfully fulfilling one's gender role should have lower subjective task value (Eccles, 1995). Gender roles mandate that women support their husbands' careers and raise children. To the extent that a woman has internalised this cultural definition of the female role, she would rate parenting and spousal support roles more important than professional career roles. Not surprising then that Rayman and Brett (1995), and Seymour (1995) both found many women giving up high status careers and advanced studies in science and engineering to take care of the family. If a girl considers that pursuing a career in science would interfere with her role as wife and mother, then she would not consider it as a viable educational or career option. Although further research is needed to substantiate these findings, these studies suggest that parents and teachers may be a subtle influence on children's science and mathematics achievement behaviors by providing or encouraging sex-differentiated activities (Meece et al, 1982).

## 2.6 Single-Sex/Co-educational Schools

Research shows that in single sex schools girls tend to have a more positive attitude towards science and mathematics, and consequently achieve higher than in a co-educational environment (Fischer, 1982; Klein, 1989). According to Ormerod (1981, quoted by Fischer, 1982), in co-educational classes, girls, especially between the ages of 12 and 14 where sex-typing is strong and quite rigid, tend to avoid academic competition with boys if they perceive that it would affect their interpersonal relationships. A survey

carried out in the United Kingdom shows that although fewer girls had the opportunity to study physics in single-sex schools, nearly a quarter of them chose to study it in years four and five of the secondary school (for students aged 14 to 16) when it was available (Harding, 1981, cited in Whyte). Although girls were more likely to be offered physics in mixed schools, fewer chose to study it. This led Harding to conclude that performance in science is strongly influenced by the school "ethos" and the expectations about girls that are subtly conveyed. Girls are more likely to see science as a male preserve when the teachers and students in these classes are predominantly male. "This conflict, which occurs at the time that science becomes an optimal course, does not occur in single-sex schools. There is less pressure on girls to use subject choice to express gender identity or to avoid competing with boys" (Fischer, 1982). In a study on U.S. Catholic schools, Lee and Bryk (1986), concluded that whether concerning academic achievement, educational aspirations, locus of control, sex-role stereotyping, or attitudes and behaviors related to academics, results indicated that single-sex schools deliver specific advantages, especially for female students. Other studies have found that girls in single-sex schools were found to hold less stereotypical attitudes on women's roles in society, including the appropriateness of women entering typically male professions (Vockell and Lobonc, 1981; Trickett et al., 1982; Lee and Bryk, 1986). Although girls may have these advantages in single-sex schools they often suffer from a restriction of available subjects, especially the sciences. According to Whyte (1986), whether a school is single-sex or not is not the most important factor, because the assumptions about the subjects appropriate for each sex are likely to be the same. She claims that there is little evidence to suggest

that all-girls schools, for instance, are superior in the sense that they make the traditionally masculine subjects more available to female students.

## 2.7 The Influence of Teachers and Counselors

Within schools, whether all-girls or coeducational, the attitudes of teachers play a crucial role in transmitting sex role stereotypes to students. A number of studies have identified differences between male and female teachers with respect to their classroom behavior, expectations of the achievement of students, or their teaching behavior. "As a principal learning resource in the classroom, and the arbiter of its social norms, the teacher necessarily exerts considerable influence on the formation of children's attitudes to specific subjects" (Whyte, 1986; p.76). A number of studies have reported that teachers interacted more with high-achieving boys than with high achieving girls (Safilios-Rothschild, 1986; Peltz, 1992; Reyes and Padilla, 1992;). These studies report for example that boys receive more attention and encouragement than female students do. Boys are more frequently praised when they give correct answers and are equally more severely criticized for incorrect answers than girls are. This is because these teachers expect boys to be naturally more interested in, and achieve better, at these subjects than the girls.

The attitude of teachers, parents and even counselors often reflects the cultural stereotypes regarding not only the supposed natural superiority of boys in mathematics and science, but also the different use to which girls and boys will put these subjects. While some girls are explicitly discouraged from taking science by their teachers and/or counselors, for others the subtle suggestion only goes to reinforce what had been imbibed

in their socialization process. In one study that reported how vocational guidance channel girls along traditional career lines, Pietrofessa and Scholssberg (cited in Whyte, 1986) report the advice given to female students who expressed indecision about whether to enter engineering or education as their chosen field. Both male and female counselors disapproved of the "masculine field". They suggested that engineering "is a man's field," "takes longer than education to train for," and "requires working after 3.00pm" (p.31).

## 2.8 Social Class

It has long been known that the socio-economic status (SES) of the home is responsible for having a substantial influence on students' achievement in science (Kotte, 1992; p.13). Common criteria used for establishing the socio-economic situation of the home were parents' education and occupation, the use of dictionary, or the number of books in the home. However to use these criteria developed in an advanced industrialized country to assess the SES of other countries, especially developing countries, becomes problematic. According to Kotte (1992, quoting Mappa, 1982), while the location and length of the family's summer vacation might be a suitable status indicator for the affluence of households in the European Community, the quality of the floor at home (bamboo, wood, cement, tiles), type of walls (woven palm leaves, bamboo, wood, cement), type of roof (palm leaves, tiles, zinc, high quality wood), type of lighting (kerosene lamp, hurricane light, electricity) were the indicators discriminating between the comparatively poor and the relatively rich homes in Laos.

Studies carried out in the United States in the 1970s indicate that lower status parents tend to accept the traditional sex roles more than higher status parents, and that lower

class fathers are more constrained by masculine sex stereotypes than middle-class fathers (Safilios-Rothschild, 1986). However, presently, the social status of the mother (such as the level of her education, and the type of occupation) has become a relevant factor to the sex role conceptions of girls (Volmam and Van Eck, 1995; Obasi, 1997). It has been reported by some studies that women who choose non-traditional feminine courses tend to come from more privileged families and to have highly educated fathers and mothers (Bach et al., 1985; Obasi, 1997). Safilios-Rosthschild (1986) notes that the few girls from low socio-economic status who achieve success in non-traditional male disciplines are less intimidated than girls from middle and upper-middle class families:

> It is possible that women from less privileged backgrounds, who may well be the first in their families to go to college, are highly selected in that they are especially talented and determined. They would thus be highly motivated to succeed. They may feel more comfortable with the idea of success because it means a lot to them and to their families and because they have had to undergo financial struggle to achieve it (p.13)

While SES seems to be effective in influencing science achievement in the industrialized countries, there seem to be conflicting reports as to whether a similar causal relationship exists in developing countries. A World Bank sponsored study of primary schools in Uganda suggested only a weak relationship between SES and achievement (Heynemann, 1976). Kann (1981, quoted in Kotte, 1992) came to a similar conclusion for Botswana. However, in two separate studies at the Awolowo University and the University of Ife (both in Nigeria), Braimah (1987, 1994) concluded, just as Erinosho (1994) did, that social class, more than academic ability, affects students' chances of attending the university in Nigeria. These authors found in their studies that women, more than men's educational opportunities, were

affected by low SES. Moreover, once admitted, "relatively low SES continued to be more closely associated with limited career expectations for women than for men" (Braimah, 1994; p.42).

Most researchers on education in Africa however, agree that the socio-economic status of the parents does have a big impact in determining the chances of a girl in entering and surviving in a secondary school. Depending on the available resources and the girl's own ability, her likelihood of attending the university becomes even more narrow. Most families would prefer sending their male children to school and encouraging the girls into early employment when the family resources are limited. There is a general agreement however, that SES operates significantly on science achievement (Kotte, 1992; p.15).

## Summary of Factors Presented in Literature

It is obvious that none of the perspectives reviewed above represents an unequivocal explanation of the under-representation of women in science courses. Rather, there are many dimensions of the issue of girls' career choice and aspirations, and consequently, many contributing variables of varying magnitude and importance. But the fact still remains that girls' personal images of the role of women in society, the perception of themselves as capable learners of science and mathematics, leading to future careers in these fields, the attitude and support (or lack of support) of adults, forms a backdrop that colors their attitudes about science and the study of science. Because in spite of the odds against girls to study science, enumerated in this review, some women have demonstrated the ability to forge a career for themselves in the fields of science and technology.

From this literature review it is clear that existing research indicate that though women can study mathematics and science and pursue careers in them, those who do not, avoid it by choice, consciously or determined by external influences (Badger, 1981; Steinkamp and Maehr, 1984). This study will attempt to seek out some possible reasons why they avoid it.

This literature search has reviewed studies that derive from different social and cultural settings, which may not be generalisable to all regions of the world. However, the review of literature did not yield any specific result in the Ghanaian educational context. This study therefore attempts to examine some of the underlying reasons why Ghanaian women, though they may be capable, choose not to pursue careers in science and technology.

This study will therefore attempt to answer the following questions:

1. How do adults' (parents, family members, teachers, counselors) expectations of a woman's career impact on a girl's career choice in the science and technology courses.
2. How does a girl's family background influence her in the choice of a career in the science and technology field?
3. To what extent does the kind of school experience (single-sex or co-educational) influence a girl's choice of study in the sciences?

# CHAPTER 3

## METHODOLOGY

This chapter describes the characteristics of students involved in this study and the factors that have been identified to have an impact on the choice of a science career program in the universities. This includes the socio-economic and educational background of parents, support and encouragement that the student receives from the significant adults in her life, the influence of peers and friends, the student's own perception of herself as capable of learning and achieving in science and how the cultural values of marriage, parenthood and career conflict in career choice decision making. A brief history of each of the three universities and its current academic program is also included. Since this study is being undertaken with the aim of revealing the responsibilities of parents, significant adults, the society and the educational institution towards the education of women in science and technology, the principles of critical theory will inform the collection and interpretation of data.

### 3.1 Participants

There were a number of practical reasons why students enrolled in the various universities were selected for this study. First, the universities tend to attract a group of students who are quite diverse in relation to their ethnic, social and academic background, thus enhancing the variability of the data. Secondly, the target group consists of women who have already made a choice. They are already in training either in the science or non-science program. So it can be assumed that the science students

have overcome such obstacles as psychological or socialization factors that drew their counterparts away from sciences during their encounter with it in the secondary schools. Thirdly, it is easier to make contact with participants who are all situated on the same university campus. This is quite important since the author is relying on other people to collect the data on his behalf. Fourthly, this target group is strategically significant in the sense that it consists of women who are presently seriously considering a career in science: they are a pool of women from which future role models can be built. Any information derived about why some of these women persisted in science, while others did not, may be useful for drawing policy guidelines for those educational policy makers interested in finding a remedy for the gender imbalance in science education in Africa. Finally, since the questionnaire is being administered without contact with participants, it is deemed best that they should be able to understand and make much sense out of what they read, and university students present the best opportunity to achieve such understanding.

The sample for this study were selected from students who are enrolled in three of the universities in Ghana: The University of Ghana, the University of Cape Coast and the Kwame Nkrumah University of Science and Technology. Also, a number of alumnae of these universities were contacted to write on how they experienced secondary school science, and how their present careers are conflicting with their marriage and parental lives. The names of alumnae have been changed to preserve their identity. The following section gives a short history of how these universities have developed and the programs that are currently offered there.

## 3.2 Overview of three of the Universities in Ghana

### 3.2.1 University of Ghana

The University of Ghana, Legon was founded in 1948 as the University College of Gold Coast; it was the first university in Ghana. In 1957, when the country gained independence and changed its name from the Gold Coast to Ghana, the university was named the University College of Ghana. Its present status and title was acquired in 1961.

Until 1961, degrees awarded were those of the University of London. In 1961, however, the University College of Ghana was by an Act of Parliament recognized as the University of Ghana, which could award its own degrees.

The university now includes two semi-autonomous schools: The School of Administration and The School of Medicine. There are five faculties: Agriculture, Arts, Law, Science and Social Studies and five research institutes: Adult Education, African Studies, Statistical and Social Sciences, Medicine, and Population Studies. The university also has three agricultural research stations in three of the towns in Ghana: Nungua, Kpong and Kade. There are 53 academic departments and student population consists of almost entirely of residential students. The number of students enrolled in during the 1997/98 academic years were 8 495 (World of Learning, 1999).

### 3.2.2 The University of Cape Coast

The University of Cape Coast was established in October 1962, as a university college and placed in a special relationship with the University of Ghana. It was constituted into a university with full authority to confer its own degrees and other academic distinctions nine years later on October 1, 1971, by an Act of Parliament.

Today, the university has four faculties: Science, Arts, Social Science and Education. It also has one semi-autonomous school – the School of Agriculture, and a Center for Development Studies. The total number of students enrolled during the 1997/98 academic year was 4 274 (World of Learning, 1999).

### 3.2.3 The Kwame Nkrumah University of Science and Technology

The Kwame Nkrumah University of Science and Technology succeeded the Kumasi College of Technology, which was established by a Government Ordinance on October 6, 1951. It, however, opened officially on January 22, 1952, with 200 teacher-training students transferred from Achimota to form the nucleus of the new college. In October 1952, the school of engineering and the department of commerce were established and the first students were admitted. Between 1952 and 1955, the school of engineering only prepared students for professional qualifications. In 1955, the school embarked on programs leading to the University of London Bachelor of Engineering external degree examinations.

A pharmacy department was established in January 1953, with the transfer of the former school of pharmacy from the Korle-Bu Hospital, Accra, to the college. This department ran a two year comprehensive course in pharmacy leading to the award of the Pharmacy Board Certificate.

A department of agriculture was opened in 1953 to provide a number of ad-hoc courses of varying duration, from a few months to three years for the Ministry of Agriculture.

As the College expanded, it was decided to make the Kumasi College of Technology a purely science and technology institute. In pursuit of this policy, the teachers' training college, with the exception of the Art department, was transferred in January 1958 to the Winneba Training College (now raised to the status of a university college). In 1959, the commerce department was transferred to Achimota to form the nucleus of the present School of Administration of the University of Ghana. By an Act of Parliament on August 22, 1961, the Kumasi College of Technology was transformed into a fully accredited university – the Kwame Nkrumah University of Science and Technology. The university started awarding its own degrees in June 1964.

Currently, the university has five faculties, two schools, three institutes, and one college, the College of Art, in addition to a number of research centers. The faculties are Agriculture, Environmental and Development Studies, Pharmacy, Science and Social Sciences. The schools are engineering and Medical Sciences. The institutes of Mining and Mineral Engineering, Renewable Natural Resources and Technical Education. The university also had the Land Administration Research Center, a Bureau of Integrated Rural Development, a Technology Consultancy Center, a Center for Cultural Studies and a Training Network Center for Water and Waste Management.

Apart from the Schools of Medicine at the University of Ghana and the Kwame Nkrumah University of Science and Technology, from which students graduate after seven years of study, all the programs in these universities take between three to six years to complete.

One hundred and fifty (150) students enrolled in science-related programs and one hundred and fifty (150) students enrolled in humanities and arts related programs,

from first year to graduate level programs, were randomly selected to respond to the research questionnaire. In each university, 100 female students (50 science and 50 non-science) were sampled to respond to the survey questions. The total number of students enrolled during the 1997/98 academic year in all programs were 7 611 (World of Learning, 1999).

## 3.3 Instruments

For a qualitative analysis of the study, the questionnaire that was developed was vetted by faculty members and pilot tested at the University of Cape Coast and then revised. The questionnaire made up of both open-ended and closed-ended questions focused on the following variables:

### 3.3.1 Family Background Factors

To examine the influence of the family milieu on the educational and occupational choice and aspirations of the sample, the structural characteristics of the family as indicators of its social and economic properties were sought. For example, the level of educational and occupational achievements of the parents. The variable father's education and mother's education variables refer to the highest level of father's and mother's educational achievement. Each of these variables was coded into six categories: none, elementary school, secondary school, post-secondary, university and post-graduate.

### 3.3.2 Factors Influencing Choice of Career Program

i. Role models: The role model influence scale required respondents to rate the degree to which parents, siblings, male and female teachers, peers, and other significant adults were

perceived as affecting educational and career choice while the respondent was in high school. Respondents were asked to rate, using a five-point scale from 'extremely important' to 'not important at all', the influence of these people on their choice.

ii. Support or encouragement of others: This variable was concerned with finding the amount of support and actual encouragement (or discouragement) the respondent received from other important people in her life (parents, peers, siblings, teachers, counselors) when she decided to enroll in a science program at the high school or the university. Respondents were first asked whether any of the above individuals had ever actually encouraged them to take, or discouraged them from taking a science program. These items were scored either 'yes' or 'no'. Then they were asked to rate, using a 5-point scale from 'extremely important' to 'not important at all', how supportive they perceived each of the significant people in their lives were if their decision was to enroll in a science class. Respondents were also asked whether a school counselor or teacher had ever given them the impression that they would perform well or poorly in a science program.

iii. Decision to Change: Respondents were given an open-ended question to give some reasons why they decided to change (if they ever considered pursuing a science career) from a science concentration to arts. Respondents were required to indicate the time they decided to switch because it can shed some light on the interplay of a number of social and psychological factors which caused these women to make the switch.

### 3.3.3 Personal Data

i. Schools attended: Respondents were to indicate the type of schools they attended, whether it was single-sex or co-educational. It is supposed that such data would give an indication on whether the type of school a woman attended had an influence on her choice of career subjects.

ii. Marriage and Parenthood: An open-ended question seeking to find whether respondents had any conflicts between career and future family responsibilities. First, respondents were to rate on a 5-point scale from 'extremely important' to 'not important at all', how the perception of marriage and parenthood affected their choice of career.

iii. Aptitude and Interests: This variable sought to determine the extent to which ability to study mathematics and science, interest and good grades in these subjects influenced respondents to choose or not to choose science as a career program. The respondents were asked to rate on a five-point scale from 'extremely important' to 'not important at all', how the above variables influenced their choice of subjects.

## 3.4 Data Analysis

The data from the questionnaire were analyzed using statistical frequency distribution to determine variations in responses. The qualitative analysis involved the critical interpretation of open-ended questions in the questionnaire.

## 3.5 Limitations

In using a self-constructed survey questionnaire, a serious concern is the validity of the instrument. To minimize the threat to instrumental validity, a pilot survey was

carried out with a small group of students from the University of Cape Coast. This pilot run was to identify any misunderstandings, ambiguities, and useless and inadequate items. Also, it is hoped that additional items may be suggested, and any time difficulties may be uncovered. An unavoidable limitation of this study was the rather small sample size. A request to the academic boards of the three universities from which the samples were taken for student's enrollment by gender yielded no response. Thus though 100 female students were randomly selected from each of the three universities (50 science and 50 non-science students) to respond to the survey questions only 96 of science and 85 of non-science students from all the three universities returned their completed questionnaire. Also, only five of the alumnae provided a profile of their liver (see Appendix A)

# CHAPTER 4

# RESULTS

This chapter compares the three subgroups of students identified for this study on the research variables identified in Chapter 3: science, non-science and non-science students who at one time in their academic life considered a science program. By analyzing the following variables— the socio-economic and educational background of parents, type of school attended, aptitude and interest in math and science, influence of teachers, parents, school counselors and perceived conflict between marriage, parenthood and career— the traits of Ghanaian women who choose a science related career program in the university emerges. Emphasis is placed in this chapter on the description and explanation of the characteristics of the students from the survey data.

## 4.1 Socio-Economic Background

The literature on role models suggests that parents' education and occupations are important sources of influence on the educational and career aspirations of the child, especially females (Kotte, 1992; Erinosho, 1994; Obasi, 1997). This research raises the following important question: what are the educational and occupational backgrounds of the parents of the respondents? Are the parents employed in science-related fields? Are the mothers of these students employed outside the home? How much encouragement did the parents give to these students who expressed a desire to pursue a career in science?

The parents' highest educational level was classified into six categories: none, primary, secondary, post-secondary (which incorporated post-secondary teacher training

college, nursing training and polytechnics), under-graduate and post-graduate degrees. The parents of both science and non-science students were of high educational and occupational status. More than three-quarters of both fathers and mothers had completed at least secondary school and pursued further studies (Table 1, fig 1, p. 101). However, on the whole the fathers seem to have attained a higher level of education than the mothers have. The majority of the fathers (55.42 percent) of both science and non-science students have under-graduate university degrees (35.42 percent for science and 20.0 percent for non-science students). This is contrasted with 42.33 percent of mothers with undergraduate university degrees (26.04 percent for science and 15.29 percent for non-science students). While only 10.82 percent of the mothers have pursued graduate work, 40.79 percent of the fathers have either a graduate or doctoral degree and are employed in executive or professional positions.

All the students in the study come from families where both parents work full-time. However, this was not a criterion set in selecting respondents; that is, requiring that both parents be employed outside of the home. The professional field of the parents was also classified into science based and non-science-based categories (Table 3, fig3, p. 104, 105). The category 'other' could not be classified because respondents merely mentioned 'teacher'. Though all the people in this category had under-graduate or graduate degrees, there was no means of determining whether their field of speciality was science or arts. An analysis of Table 3 indicates that more students in science programs than in non-science programs have parents in science-based professions. While all mothers of students in the arts and humanities, who were in science-based professions, were nurses, students in the science programs had mothers who were engineers (3), doctors (7), nurses

(10), lecturers in various science departments in the universities (5), or in computer science (4). There were several instances of both parents being in science-based professions for science students. However, an analysis of the data revealed no such case for students who were in the arts or the humanities. Among the students pursuing engineering, computer science or math majors, it was always the case that one or both parents would be found in a science-based profession.

Generally, a high proportion of the parents of both science and non-science students were found in professional occupations that were not science-based. This may be a result of how the past educational system had concentrated on arts and the humanities at the universities.

### Summary of Findings

Ghanaian students who gain access to the universities are most often from higher SES families. The findings reveal that the more educated parents are, the less stereotypical the values and norms they hold about their daughters. Given their higher SES they can forgo the immediate economic returns that their daughters' early entry into the labor or marriage market would have brought to the family. Science students tend to have mothers or fathers who are themselves employed in a science based career.

## 4.2 Choosing a Career Program

An individual can almost always identify a variety of motives for making a career choice. It could be the status prospect or the financial reward that career promises, or personal interest and/or self-rating of ability to cope with that program of study. It could

also be that the individual has no other option other than that which has been made available – as is the case with some Ghanaian students because of the limited number of available places in the universities. Other motives for a choice of career program could be the influence exerted (either directly or indirectly) by parents, teachers, counselors, peers, or significant others in the life of the individual. Another external factor may also be the academic atmosphere prevailing in the secondary school that the individual attends.

### 4.2.1 Career and Ability to Study Science

A number of factors were identified as important in this context and respondents were asked to indicate the extent to which each factor influenced their choice of career subject. An analysis of Table 7 (p.115) shows that in the case of science students, the majority (53.13 percent) considered the extrinsic rewards and social status that their chosen profession would bring as the most important factor for the choice they made. As one alumna (Alice) puts it, "personally I enjoy being in a predominantly male career because people really look out for you and want to know who you are. The attention and protection I invariably get makes me think all men engineers are ordinary whilst their women counterparts are special beings" (Appendix A.1 – Profile of Alice). An important point that emerges here is that these students assumed that they had the ability to succeed in their field of study, hence the issue of ability to study did not seem important. Only 19.79 percent chose their program because they felt their ability to study it was more important than any other reason. This result is similar to those in the non-science programs. The overwhelming majority (74.12 percent) decided not to pursue a science

career because they had a career aspiration in another field that seemed more lucrative and fulfilling. While 20 percent chose another field of study because they did not find the study of science at the higher academic levels interesting, 5.88 percent abandoned their desire for a science-related career because they did not feel they would survive the competition that would admit them into their desired program. This does not mean that they felt they would not be able to achieve in a science career, but because there were so few places in the various science programs in the universities, a lower science grade would not guarantee them a place in the university.

### 4.2.2 Type of School

The type of secondary schools that respondents attended (that is, whether single-sex or co-educational) was found to possibly influence the students' choice of field of study in the universities. In the science and non-science sub-groups of students, 65.63 percent and 48.24 percent respectively, attended single-sex secondary schools (Table 2, p. 102). An analysis of the data shows that more students in the science than in the non-science programs attended single-sex secondary schools. This reflects respondents' high socio-economic background, for it is more expensive sending a girl to a single-sex secondary school than to a co-educational school. Also, because of the high academic and disciplinary standards in these schools, the entry requirements tend to be very demanding and competition very keen. It is known that 96 percent of students who went to these schools come from high socio-economic backgrounds.

Within the science sub-group, 65.65 percent attended single-sex secondary schools while 34.37 percent attended co-educational secondary schools. Also, the data

shows that among students who attended the single-sex secondary schools, more students (41.67 percent) from the senior secondary schools (the new educational program) than from the sixth form program (23.96 percent) chose science. Whereas in the co-educational secondary schools, more students in the sixth form program (22.91 percent) than in the senior secondary school program (11.46 percent) chose science.

Analyzing the data in Table 2B (p. 103) by type of school and educational program (that is, whether the old or the reformed program- the senior secondary schools) reveals that the majority (77.14 percent) of students who opted for either the physical sciences (physics, math and chemistry) or engineering or computer sciences attended the sixth form secondary schools. For those who attended single-sex secondary schools 75 percent entered the university through the sixth form program, while 25 percent were from the SSS program. Of those in the co-educational schools 81.82 percent came from sixth form schools, while 18.18 percent were from the SSS. This result indicates the difficulties students enrolled in the reform program face with the science curriculum of their program.

### 4.2.3 Perception of School Science.

An attitude toward school science scale measured whether students found science difficult, enjoyable, difficult when science involved calculation or laboratory experiment, and whether science teachers made science lessons interesting (Tables 4 A and B, 106,107). Despite the observed differences between the science and non-science sub-groups, it was the question about whether or not students enjoyed school science was what really did distinguish between them. Both the majority of science students (92.63

percent; Table 4A, p.106) and non-science students (93.20 percent; Table 4B, p.107) found the study of science enjoyable. Of the number of non-science students who enjoyed the study of school science, 66.67 percent had at one point considered pursuing a career in science, while 26.53 had never had an intention of pursuing a science career (Table 4B, p.107). Another factor that distinguished the science and the non-science subgroups was how easy or difficult they found science as a school subject. While only 22.34 percent of science students (Table 4A, p.106) found science a difficult subject to study, 75 percent of non-science students (Table 4B, p.107), who at one time considered a science career, found science a difficult subject. For non-science students who never considered a science career (Table 4B, p.107), 87.76 percent found science a difficult subject. When science involved calculation or laboratory work non-science students (both those who changed to arts and those who never considered science as an option) differed drastically from their counterparts in the science programs. The few science students (40 percent) who found science difficult when it involved calculation were all in the biological sciences. Mathematics students found laboratory work tedious and time consuming. For the non-science students, 88.89 percent of those who considered a science career and 93.88 percent of those who never did consider a science career, found science difficult when it involved calculation (Table 4B, p.107). Non-science students were very critical about science teachers. The majority felt that teachers took too much interest in those students who were good in class while ignoring the others. This feeling is reflected in the answer of the 69.44 percent of respondents who considered a science career and 83.67 percent of non-science students who never considered a science career; that science teachers did not make science interesting (Table 4B, p.107). Their major

complaint was that teachers expected them to memorize facts that they considered meaningless. However, they admitted that this view of teachers was not the major influencing factor for their loss of interest in science.

Although the majority of respondents were positive overall about secondary school science, they did express having problems studying particular subjects. Science students majoring in agriculture, medicine, and the biological sciences mentioned having difficulties grasping some math and physics concepts. Conversely, students in the physical sciences, computer, and engineering disliked biology. Non-science students were unanimous about their dislike for chemistry and the abstract nature of physics, especially topics on atomic and nuclear physics.

Whether respondents enjoyed a particular science subject or not also played a significant role in their choice of career program in the university (Table 6A and B, p.111, 113). Though non-science students rated their ability to study science subjects positively, they preferred to choose a career in a non-science-related field. The majority of these respondents (62.35 percent) considered their career aspirations in another field 'extremely important' or 'very important' (20 percent) enough to change their minds from pursuing a science career to a non-science one (Table 6B, p.113). The financial reward and the social prestige that a particular occupation held for the individual also played a very important role for the selection of majors in the university for the science students. Though their ability to study science contributed significantly to the choice they made, 61.46 percent felt their career aspiration in selecting a science career was 'extremely important' (Table 6A, p.111)

### 4.2.4 Science and Math Teachers

Table 11 (p.129) shows the distribution of science teachers by gender. In both single-sex and co-educational schools, science teachers were predominantly male. Even in the all–girls' schools, science teachers were predominantly male. More than half of the respondents (57.14 percent) from all-girls' schools reported that science teachers were 'mostly men' and 20.64 percent reported that science teachers were 'all men'. Only 22.22 percent of the respondents from all-girls' schools reported that they had an equal number of men and women science teachers. Non-science students also reported the over-representation of male science teachers in the secondary schools.

Undoubtedly, these findings reflect the problem of the under-representation of females in the study of science at higher educational levels. In spite of their seeming over-representation, male teachers can take some credit for the positive attitude towards science that they were able to cultivate in some of the students. An analysis of the columns 'science teachers' and 'math teachers' in Tables 9A (p.124) and 9B (p.126) show that for a majority of these respondents math and science teachers had a tremendous effect on their decision to either pursue or not to pursue a science career. This is not surprising considering that the majority of schools in Ghana do not have a professional counselor. Thus subject choice will have to rely on students' preference and the teachers' willingness to accept a student into his or her program. Science teachers seem to have had a greater impact on students' choice than math teachers, probably because math is a compulsory subject for all students – science and non-science alike. From Table 9A (p.124) we notice that 19.79 percent of science students felt that science teachers'

influence on choice of subjects was either 'extremely important', while a 38.54 percent felt their influence were 'very important'. The non-science students did not share this positive impression about science teachers. The majority of them were of the impression that science teachers were partly responsible for their loss of interest in pursuing a science career. According to some of the respondents some teachers gave the impression that it is only 'clever' students who achieve in science. From Table 9B(p.126), respondents felt science teachers' influences were 'extremely important' (36.48 percent) or 'very important' (34.12) in concretizing their decision not to pursue a science career. Almost half (44.71 percent) of the non-science students felt math teachers' influence on their decision not to pursue a science career was 'very important', while 9.41 percent felt it was 'extremely important'. This perception of science and math teachers is reflected in the over three-quarters of non-science students' response that science teachers did not make science interesting (Table 4B, p.107).

### 4.2.5 Counselors and Counseling

Within the present educational system in Ghana, there are no resident professional school counselors. Often, the school principal or the headmaster appoints a teacher to double as a counselor to the students. Periodically, especially before students make a choice of subjects, career counselors from either the universities or the Ministry of Education would be invited to give a series of lectures to these students. Thus, though from Table 10 (p.128) there is indicated 'counselors' and 'no counselors', it should be understood more to mean students who had an opportunity to meet with these 'invited' professional counselors, or students who never had any encounter with professional

counselors. Subject choice and career-planning advice within the school environment is done mostly by subject teachers.

Tables 13 (p.131) presents the data for students who received counseling from either a teacher or professional career counselor. The non-science column is for students who, at one point in their academic life, considered pursuing a science career. The data reveals that many of the science students (81.25 percent) were given positive encouragement by their teacher/counselors to pursue a science career. The other 18.75 percent claim they were not so much told they would not do well in science as in the particular career they had in mind. All 18 respondents who said they were asked to consider other programs indicated that the recommendations were the result of low grades they obtained in some of the science subjects, hence, that would affect their chances of gaining admission into science programs in the universities. The 18 respondents were majoring in biological sciences (13), physics (3) and math (2). Students in the biological sciences had had the desire of enrolling in the medical school or the school of pharmacy. The physics and math students said they had to settle for those majors instead of engineering, computer science or architecture.

Non-science students who considered a career in science claimed that their decision to change their major was not so much the result of counseling as about poor performance in physics and chemistry, and for some of them math. Thus, from the column 'counselor' in Table 9B (p.126), which seeks to determine how important the influence of counselors were on decision to switch from science to arts, a majority (50.59 percent) of the respondents said it was 'not at all important'. No doubt many of them did not receive any counseling, or by the time counselors could intervene they had already

made up their minds what they wanted. Two engineering and three computer science students said they were told they should consider changing their preferred programs because their math grades were not strong enough.

### 4.2.6 Influence of Significant Others

The person an individual is most often in contact with often affects his or her career aspirations and choice. An examination of the people who had the most significant impact on respondents' career-related decision reveals a strong parental influence in the case of science students (Table 8A-1, p116). While 25 percent of science students felt their mothers' influence on their decision was 'extremely important', 19.79 percent felt their fathers' influence was 'extremely important'. Non-science students were the least affected by parental influence in not pursuing a science career, even among those who considered a science career (Table 8B-1, p.116). The majority rated their fathers' and mothers' influence on their decisions as 'barely important', 35.29 percent and 44.70 percent respectively. On the other hand a large proportion of science students (25 percent) felt their mothers' influence on their decision was 'extremely important' and 37.5 percent felt mothers' influence was 'very important'. Fathers' influence was also quite significant: while 19.79 percent felt their fathers' influence was 'extremely important' 28.13 percent felt it was 'very important'. The strong relationship between parental influence and career choice for science students may reflect respondents' perception of their home environment.

Peer influence was not perceived as playing any significant role in the respondents' determination to enroll in any major, either science or non-science. Neither

science nor non-science students appear to have been affected by peers or friends. From Tables 8A-2 (p.118) and 8B-2 (p.121), 47.92 percent of science students and 61.18 percent of non-science students considered the influence of peers in their choice as 'not important at all.' Likewise, from Tables 9A (p.124) and 9B (p.126), 37.50 percent of science and 48.24 percent of non-science students considered the influence of their friends in school on the career choice they made as 'not important at all.'

Other family members had very little influence on respondents' decision to pursue a particular career program. Incidentally, only two students in the non-science sub-group responded to this question. Both said they could not recall any family member making the least attempt to influence their choice of career. Respondents in the science sub-group who had relatives in science-related careers were most likely to consider careers in the sciences, especially when their own parents were also in science careers. Thus, 2.08 percent felt family members' influence was 'extremely important' and 4.17 percent said it was 'very important' to them.

Though respondents saw these significant adults' influence as important to their choice of career program in the universities, the overwhelming majority saw their own self-confidence and future career plans as the most important factor which determined the choices they made.

## Summary of Findings

Many factors were identified as playing a role in students' choice of a major in the university. The importance that the student assigns to the people in her life, especially her parents, teachers, counselors, and friends; internal motivators, such as

interest and ability to study a particular subject; to specific external aspirations such as future jobs; and the kind of secondary school the student attended. Overwhelmingly, respondents in both science and non-science subgroups indicated that their choice of program were affected primarily by their thoughts of future careers, followed by their interest and aptitude in the particular subject of their choice. Teachers and counselors may have discouraged a few of the respondents from their initial choices. Parents and teachers became less important influences than internalized motivators did. Respondents generally have a strong self-image concerning their academic abilities. However, parents' opinions were valued more by those who said their parents gave vocal evidence of support and encouragement. Teachers frequently served as a source of support as well. The findings also indicated that single-sex girls' schools affect Ghanaian girls positively, both by increasing science achievement and by engendering less stereotypical views of female occupation. This suggests that such schools have a powerful positive effect on their female students. In the light of earlier studies on girls' education in Ghana (STME, 1998) which suggested both that girls generally were educationally disadvantaged and that single-sex schools were particularly likely to experience lack of science resources that may have contributed to that disadvantage, this conclusion is gratifying.

## 4.3 Career and Family-Role Conflict

For students enrolled in the arts and the humanities and those who attended the sixth form (even for the science students), there was a strong positive relationship between career, marriage, and family roles. However, there was not a strong relationship between these variables for students who attended the SSS and those enrolled in the

sciences. From Table 13 (p.131), 13.33 percent of sixth form students in the sciences and 25.43 percent of sixth form students in the non-science felt that aspiring marriage and parenthood was 'extremely important' in their choice of career. A further 17.78 percent of sixth form science students and 10.17 percent of sixth form non-science students felt it was 'very important'. The majority of respondents in both sub-groups (from the sixth form column) considered the issue of marriage and parenthood 'somewhat important' to their choice of career program. The students from the SSS program were the least interested in the issue of marriage, probably because when they were making their career choice they were quite young. The average age of an SSS student who enters the university is about 18 years. The majority (41.18 percent) of science SSS students considered the issue of conflict between marriage and career 'barely important', while 31.37 percent considered it 'not important at all.' Of the non-science SSS students, 57.69 percent considered the issue of marriage and choice of career as 'barely important', while 19.23 percent considered it 'not important at all.' These data may suggest that while career aspirations and marriage and family plans may not have an important relationship for these young SSS students and students in science-related programs, there is an important connection between these two factors for students coming from the sixth form and non-science students. For the sixth form students, who enter the university at an average age of twenty-three, the fear that time might be running out for them is real. For most of the SSS students, the fact that they come from families who would be able to take care of their needs while in school also adds to their not putting much importance on early marriage.

The majority of respondents expressed the desire to eventually get married and expected a conflict between family life and career responsibilities to arise. However, for the moment, most of them from both sub-groups expressed the desire to pursue a career over the objections of a prospective husband. This attitude seems more prevalent with students whose mothers were highly educated and are employed in executive positions.

The minority in each sample who were consistently non-career oriented in their responses did not anticipate any conflicts between family life and career, because they felt their male partners would be able to support the family even if they gave up their careers.

The majority of respondents, but particularly science students (especially the engineering and medical students) expected their own careers to be as important as a potential spouse's career and to be as important as their roles as wives and mothers.

Generally, students who were relatively less interested in marriage and thus more committed to careers were those in the physical sciences, engineering, and medical school.

## Summary of Findings

All the respondents in the study expected to be married, but would combine their careers with marriage and parenting their children. These young women did not see motherhood and careers as mutually exclusive, but rather a combination to which every woman must aspire. There were no significant differences among the various sub-groups, which reflect this perspective. Although the sixth form group in both the science and the non-science sub-groups indicated some concern about the delay of their marriage

because of the length of time their studies would take, they were unanimous in saying that they preferred establishing a career before settling down to marry. Probably because of their age, students from the SSS program were the least concerned with the issue of marriage.

## 4.4 Non-Science Students who Considered a Science Program

These students comprised that group of 36 respondents who had at one time in their academic career indicated an interest in pursuing a science career, and then decided to change and are now majoring in a non-science program. I separate this group from the non-science sub-group because they tell us more about the conflict that these student girls face than those who never had any ambition of pursuing a science career.

Less than half of the 'considered' students had a parent employed in science career. However, unlike their other non-science counterparts, the 'considered' were more likely to have received some discouragement from parents or siblings at home. As one alumnae who is now pursuing a Masters program in nursing wrote:

> "I had always wanted to take up a career in science, even in the sixth form. But my physics was so bad that I had to give up.... My brother who is a lawyer thought that since my ordinary level examination results in the arts were very good any further educational pursuits should be in the arts." (Appendix A.4: Profile of Lynda).

This respondent felt she had to take an arts program at the university. However, coming to the United States with her husband she found that she could still pursue the program of her dreams.

These students who considered a science career were more likely than other non-science students to have enjoyed science in the secondary school, but somewhat less

likely to have enjoyed it than science students. Table 4C (p.108) shows that 66.67 percent of these 'considered' students enjoyed science compared with 26.53 percent of other non-science students and 92.63 percent of science students. Likewise, 'considered' students gave more credit to teachers of science subjects than their non-science colleagues, but less so than science students.

Perhaps what might have convinced them that if they did not change they might not gain admission into the university to pursue their studies in a science career (apart from the overt or subtle influence of other people in their lives), was how difficult they perceived science subjects, especially physics and mathematics. In response to question 9C (p.96) of the survey questionnaire, as to whether they found any particular science subject abstract, the overwhelming majority (about 96 percent) mentioned physics. Math came a close second with chemistry following. This is reflected in their response to the question 'whether science was difficult when it involved calculation?' An overwhelming majority (88.89 percent) responded 'yes' to this question (Table 4C, p.108). Apparently, most of these students had planned a career in the biological science.

In choosing a career, students who considered a career in science were influenced more by teachers and parents than were their science or non-science counterparts. However, teachers did influence them more than did their own parents. From Tables 8C 1 to 8C-3 (p.123), 47.22 percent felt their teachers' influence, conveyed subtly or upon their advice to change played a 'very important' role in their final decision (Table 8C-3, p.123), only 25 percent (Table 8C-2, p.123) felt their fathers' and 27.78 (Table 8C-1, p.123) percent of mothers' influence was 'very important'. While 25 percent considered their teachers' influence 'extremely important' (Table 8C-3, p.123), 22.22 percent felt

their mothers' (Table 8C-1, p.123) and 30.55 percent of their fathers' influence (Table 8C-2, p.123) was 'extremely important' to the decision the made in choosing to major in the arts or the humanities in the universities. The effect of these teachers on the career decision making of these young women calls for an in-depth research and policy formulation.

The next chapter discusses how these findings have implications for educational policy and practice.

# CHAPTER 5

## DISCUSSION

In Chapter 4 (p.32) a number of variables were examined to determine their impact on Ghanaian women students' choice of science programs in the universities. The profile of the science student that emerges is of one who came from a high socio-economic background, had parents who were highly educated, probably attended an all-girls' school. The science students have a high self rating of their academic abilities. The variables mentioned in Chapter 4 are discussed further in this chapter to answer the three research questions that were posed in Chapter 2 (p. 32).

As the results of this study indicate, several factors related to the under-representation of women in science and technology named in previous studies (for example, Volman et al., 1995, Beoku-Betts, 1998, Stromquist, 1998, etc.) surfaced. All these factors have implications for further research and for educational policies and practice. However, it should be noted that even though in some cases significant differences were observed between science and non-science students and, even within the same subgroup between single-sex and co-educational school student, between senior secondary school and sixth form students, these findings reveal only the association with respect to the clusters of variables in the study. That is, this study did not attempt to canonically conclude what is the true cause-and-effect relationship between these variables and women's under-representation in science and technology programs. However, for purposes of formulating educational policy and recommendation, an attempt would be made to speculate the cause of certain associations found in the study.

The overall profile of females who choose science-oriented programs of study in the universities which emerges from this study suggests that they come from a certain social background: parents with a high education and high status careers; and, either one or both parents has a career in science. The majority of the students attended single-sex schools. The personal characteristics of these women include a positive attitude towards the study of science. They tended to rate themselves highly in their ability to succeed in their chosen career. They were not easily influenced by peer and friends, and have a fairly clear idea about what their options will be when the conflict between careers and marriage and parenthood arose.

I begin this discussion by looking at those factors related to the students' background that distinguished them from the majority of females in Ghana.

## 5.1 Family Background

An analysis of the data revealed that Ghanaian female students who opt for science-related career programs share similar social backgrounds with Nigerian women scientists, as Erinosho (1994) reports. Namely, they have parents with an undergraduate degree or higher, with one or both in a science-based profession. These outcomes "underscore the importance of home environment in conditioning girls to a particular behavior pattern" (Erinosho, 1994; p.211). The relatively high socio-economic status (SES) of the parents possibly allow these parents to learn norms and values that are less stereotypical of the general population, but more "egalitarian towards women" (Braimah, 1987; p.575). The relative economic security of these high SES families, who paradoxically have fewer children, allows them to support their children's educational

careers in a manner that exceeds the normal support roles of families within the Ghanaian social context. For example, the children of the more highly educated and economically secure parent, apart from the certainty of their being sent to school, are more likely to acquire some measure of literacy at home before starting kindergarten. Conversely, the educational prospects of the children of the less well-educated parents, who come from a lower SES, depend on their gender, how much sacrifice the family can or are willing to make, and the child's birth order. Children of high SES parents have the opportunity of being provided with many educational materials in the home. Their parents spend more time teaching and reading to them than the children of the less well-educated parents do. Also, the children of these well-educated parents at an early age learn how to speak and write the English language at an early age. This is because they hear English being spoken more frequently by their parents at home than the local dialect. Thus, the children of the more highly educated parents are better prepared for school, and hence will experience a greater degree of home – school continuity than will the children from the less well-educated and lower SES background.

The tutoring that children receive at home has another positive effect on their future educational career. According to Laosa (1982), studies have provided confirmatory evidence for the general hypothesis that the parents' choice of teaching strategies can influence the child's development of learning strategies. He writes,

> It seems reasonable to hypothesize that children of parents who habitually teach through modeling will develop a learning strategy characterized by 'observational learning' or learning 'through looking'; by contrast, children of parents who typically teach through inquiry might develop a learning strategy or information-processing approach characterized by 'going beyond the information given' or by verbal symbol manipulation (p.799).

For example, it stands to reason that the more educated parents may be the better they would be able to transmit the style of teaching and learning they had experienced in their own education to their children. As LeVine (1980) points out:

> The classroom introduces a person to a new kind of interaction between adult and a child – one in which the adult asks the child to display her knowledge and then praises the child when she/he is right. Thus the classroom instruction provides a new style of discourse worthy of imitation. When they become parents themselves, they take the role of teachers with their infants and engage in reciprocal vocalization, questioning, and praise as their teachers did to them (S103).

It must be assumed that the more educated a person is the better she/he would be able to play this role. Thus, uneducated parents, because they have not been exposed to this kind of adult-child interaction, would be the least able to transmit this to their children. As a result of the logistics and personnel problems that besieged the implementation of the 1987 educational reform program, most parents are spending more time tutoring their children, or, for those who can afford the cost, hiring private teachers for their children. Therefore, it comes as no surprise that the children of the more highly educated parents learn to master in their homes the form and dynamics of teaching and learning similar to the regular school classrooms. Given this relative similarity, "the interactional processes that these children learn to master at home will have adaptive value in the classroom" (Laosa, 1982; p. 799). Therefore, insofar as the children of the more highly educated and high SES parents learn to master classroom-like 'interactional processes' in their homes, they will have a decided advantage over the children of the less well-educated and lower SES parents. This is because the children of the lower SES parents start school with little or no knowledge of the dynamics of teaching and learning processes that take place in the school classrooms. It is therefore not surprising that the majority of students in science,

especially in engineering, computer science, and the physical sciences, almost always had either the mother or the father or both parents in a science – related career. Possibly the parents' own interest in their career subject gave them the opportunity (which may not be available to the children from lower SES background) to provide their children with as much science experience as the children could grasp at each level of their intellectual development.

Hence, it is reasonable to hypothesize that the contrast between science and non-science students' perception of a science career for themselves; their interest in science as a school subject; and, the teaching of science found in this study may have arisen as a result of how the "relational systems" (Laosa, 1982; p. 799) of home and school had been established and developed. For if no 'relational system' with respect to teaching and learning had been built in the home, as in the case of many children from low SES, the children and the school teachers will be unable to draw on a shared process of teaching and learning. Thus the children of parents of high SES and high educational levels will always have an advantage over the children of parents of low SES, not only in science, but also in all other subjects. It is in this light that one must understand that most of the respondents in this study, and females in Ghanaian universities in general, come from a far less representative cross section of the Ghanaian society. With this advantage in learning, these 'privileged' few will invariably out-perform their counterparts from the lower SES in national entrance examinations into both the secondary schools and the universities. Therefore it comes as no surprise that the majority of the respondents in this study from both sub-groups come from middle-to-upper socio-economic backgrounds.

This resultant inequality of access to secondary schools and subsequently university education will eventually widen the already existing gap between the children of low income parents and the children of professional high income parents as is currently the case with the effect of the structural adjustment program (SAP) adversely affecting many households.

## 5.2 Encouragement to Pursue a Science Career

The social milieu in which an individual is brought up affect his or her self-perception, goals, and values. Thus children from different SES in schools would be expected to acquire different self-concepts, different patterns of expectations for success in various aspects of life, and different values and goals in life through the process by which they were socialized into their communities. According to Eccles (1994):

> Socialization experiences can affect the educational and career choice individuals make because of the direct or indirect influencing behaviors and attitudes of the people the individuals are exposed to as they grow (p. 590).

Thus students will develop different self-perceptions, different perceptions of education, and different career options, depending on the kind of feedback they receive on their performance in various school subjects from parents, teachers, counselors and other significant adults in their lives. Also the advice students receive on the importance of various school subjects and career choices that they should be considering, with respect to their gender role, shapes the kind of educational and career choices they make. An analysis of the data in this study reveals that the level of perceived encouragement from parents, teachers, counselors, and other significant adults is related to whether or not a student actually chooses a science career program. Though respondents did not credit

these adults as being a source of major influence in their choice of program as they do other factors, they do acknowledge receiving varying forms of encouragement from these people to study science or consider other career options. Perhaps, as Rayman and Brett (1993) notes,

> Students at this developmental stage want to own their own decisions; while they recognize encouragement, they do not want to acknowledge that this encouragement has shaped their choice (p. 48).

Though the survey question 15b (p.100) required respondents to indicate whether a teacher or counselor had ever given the student the impression that they would either succeed or not succeed in a science career, the majority of respondents added the attitude of parents was also vital. This is probably because, as had been stated earlier, most of these students never had the opportunity of meeting with a professional counselor. Parents and secondary school teachers were generally perceived by most science students (81.25 percent) as encouraging them to pursue a science career. It is encouraging to note that mothers', more than fathers' influence was rated as being more significant by these science students. This is because it shows how Ghanaian women are gradually breaking away from the stereotypical view of women and career. When, however, the respondent listed the influence of both parents as highly significant, even though the parents may be coming from a low SES, there was a strong sense of self-esteem and personal high ability rating of the student. This finding of the influence of mothers and the ability of students emerging from the analysis has an important educational significance, because it creates an avenue for educational policy makers to device intervention strategies for the educational and career aspirations of girls in the secondary schools. For example, parents

(irrespective of their socio-economic status) could be taught to take more interest in the educational and career aspirations of their daughters and direct them toward that goal.

The lack of parental involvement in career decision making is reflected in the responses of the non-science students. The majority of these respondents, even among those who considered a career in science, rated the influence of parents on the decisions they made as 'barely important' (Table 8B-1, p.119). What is clear within this sub-group is the fact that the majority of them are sixth form students who have been asserting their independence in making choices about their future. If one considers the fact that most of these students did not have the opportunity to meet with a professional career counselor, such actions pose a serious enough challenge for educational policy makers to take note of. As Eccles (1994) notes, although individuals may choose from among several educational and career options, "without proper direction they would not consider the full range of objectively available options in making their decisions" (p. 589). Because these students may not be aware of their existence, many career options are never considered, while "other options are not seriously considered because individuals have inaccurate information regarding either the option itself or the possibility of achieving the option" (Eccles, 1994; p. 589).

It became clear in this study that some teachers did influence the educational and career path of some respondents from both sub-groups. Many mentioned teachers who advised them to choose, or drop, particular subjects because they stood a better chance of passing those subjects either at the Ordinary Level Examinations or the university entrance examinations. It is curious that these teachers were not considering the career options for these students. The practice of classroom teachers acting as career counselors

calls for some concern because many of these teachers have only a limited knowledge of career options outside of academia. For example, they may inadvertently encourage students to follow their (the teacher's) own footsteps. Just how many of these students, following the advice of teachers, have opted for careers that are not suited for them may never be known.

The conclusions drawn from this study must be considered with a bit of caution due to the small sample size and the fact that the questionnaire was developed specifically for this study. Although replication cannot be guaranteed, it can be inferred from the data that the relationship between significant adults clearly differentiates between students who would enroll in science and those in non-science career programs.

## 5.3 Single-Sex and Co-educational Schools

The result in this study indicates that single-sex girls' schools provide young women with a positive nurturing environment where they can develop and pursue science interests. The relatively high enrollment figures of young women in science from single-sex senior secondary school program found in this study lends credence to the finding of other studies (Gillibrand et al., 1999) which contends that single-sex girls schools offer advantages for women to achieve in science. Compared with their counterparts in the co-educational schools, the results show that single-sex girls schools afford an environment that provides young women with appropriate role models (even if it were fellow senior students), has the potential to release girls from the social pressure of competing with males, and enables young women to assume leadership positions. This environment provides an incentive to excel academically, pursue non-traditional academic careers, and

to develop more expansive aspirations for higher education and for professional careers (Smock, 1981; p. 78). The all-girls environment also helped to minimize the stigma of being a 'smart girl' because all the students in the science class were equally smart (Monhardt et al., 1999). The findings also show an important change of orientation occurring in Ghanaian single-sex secondary schools, which previously concentrated in preparing women for studies in the arts and humanities in the universities.

In spite of the encouraging outcome from single-sex girls' schools, one fact that came out clearly was that students who went to these schools differed in their social backgrounds from their counterparts in the co-educational schools. The majority of these students have parents in high SES with their mothers having university degrees or above. This suggests the elite character of single-sex secondary schools that automatically exclude the vast majority of Ghanaian girls who come from a relatively low SES. These single-sex girls' schools seem to have more privileges than the co-educational schools, despite the fact that all the schools are government schools. They have a low student/teacher ratio, as well they receive more and better educational resources from government. This privilege may be due to the fact that most of the students from single-sex schools are able to pass the university entrance examinations, and government officials in charge of distributing educational resources to the school choose to send their children to these schools. While it is likely that the sex composition of the student body affects the educational process for girls, the issue appears to be more complex than a simple distinction between single-sex and co-educational schools. The majority of respondents in this study who went to single-sex senior secondary schools are to be found in biological sciences. This reflects the imbalance in the distribution of mathematics and

science facilities that have plagued these all-girls' schools since the colonial days, despite the massive impute of science facilities that had been made in recent years.

The typical situation of the under-representation of women in science is reflected in Table 11 (p.129), where predominantly male teachers teach female students. This means that these girls often lack effective female role models as they enter puberty and are called upon to make significant decisions regarding their schooling and future. If these male teachers hold stereotypical ideas about the appropriate course of study for a woman and her role in society they may lead these girls to accept that role.

## 5.4 Conclusions

The literature on the education of women in Africa has advanced many reasons for women's lower participation in education, including early marriage, early entry into the labor market, deferring their schooling in favor of that of their brothers' and being burdened with household responsibilities. Despite the importance of these problems, my main interest is in those women who do proceed to higher education. This study set out to find whether the educational system in Ghana is structured in such a way as to discourage women from pursuing science and technology career courses.

The study revealed that non-science students, and those who at one time considered a science career but changed to arts, shared common traits and experiences. Although there were social distinctions among these respondents, the majority came from backgrounds of low science interest, which has implications for their development of science interests. Though mothers who were nurses were categorized among science-careers, the amount of science courses these nurses have to take in the secondary school

to qualify them into nursing school is the same that any non-science student has to take as a prerequisite to enter into the sixth form and subsequently into university. The home environment of these non-science students may have had an affect on their perceptions of science, and limited the opportunities they had for the growth of interest in science as a school subject as children. This suggests that perhaps early science interest could be an important precursor of positive attitudes towards the study of science in the secondary school. By strengthening the family commitment to science and enhancing the opportunities for science interest to develop in children, the school may have greater success in nurturing that interest through involvement in more science-related activities in the classrooms.

The evidence presented in this study, concerning parental education and career orientation and their daughters' educational and career aspiration, is admittedly preliminary and fragmentary. Yet the influence that mothers' education had on the science students suggests that the level of education of the parents, especially the mother, may affect the way they would behave towards their children. The higher a person's educational level, the better the person is able to inculcate the attitudes and values that he/she has acquired in school into the situation of parenting. Thus these parents are able to influence the behaviors of their children in ways that bares on the children's later attitudes to the school classroom environment.

Notwithstanding the differences in the pre-university experiences of science students or the doubt generated by a generalized cultural discouragement from the pursuit of traditional 'male careers', reflected in Josephine's profile (Appendix A.1 –Profile of Josephine), the majority of respondents chose their career programs based on: the

attraction of these careers in terms of higher salary and the prestige it carries, self-confidence in their ability to succeed, and, a great deal of encouragement from family and teachers. The predominance of male science teachers generates some concern because of the tendency of male teachers to treat females like males, or make females and males alike. As Seymour (1995) points out,

> If a male teacher challenges everyone in his class to *'prove' their manliness by standing up to the harshness of their teaching methods, curriculum pace, and assessment,* (italics mine) teachers are sending out meaningless messages to female students (p.461).

Such teachers only succeed, by this "masculine attitude", to discourage females from participating in their lessons. This is because while men may be comfortable with these challenges and competition (for example, to be acknowledged as the best in the class or to have he best grade in an examination), women have been socialized to believe that "'proving yourself', while an appropriate form of gender-defining activity for men, is risky and inappropriate for women" (Seymour, 1995; p.462). Female students would not know how to respond appropriately to this. Those few female students who would rise to meet these 'challenges' intended for young men by showing ability and competence, exposed themselves to the risk of being regarded less than feminine -'super-women' (Seymour, 1995; p.462). With the paucity of women's studies in Ghanaian universities, there is no doubt about the fact that these well-meaning teachers have been conveying negative messages to their students. This may account for the over-representation of female students in biological sciences.

The results of this study also suggest that while marriage and parenthood seem important to these young women in this study, for the moment, it comes as a second

option to their career options and the expansion of their occupational horizons. This observation presupposes a radical shift in attitude and orientation of these young women as a result of education, and possibly family influence. The traditional expectation for a young woman is that she would depend on the husband's income for family support. However, this does not seem to be what these young women are planning for their family life. The results of this study provide some information about the career and parenthood expectation of this group of students in Ghanaian universities. However, it must be stated that the extent to which these expectations will be realized would be better revealed through longitudinal research. The majority of the respondents plan to delay their marriage and childbearing till they have established themselves in their work. Although science students and students from the SSS program (who are obviously younger) are more inclined to be career oriented than non-science students and students of the sixth form program, the majority of the respondents are not expecting to subjugate their career goals to those of a marriage partner. However if the experiences of the alumnae with respect to combining parenting with career is anything to go by, then these young women are not really aware of the task ahead of them. As Alice points out,

> Parenting for a female engineer, and I suppose for most other presumably male dominated professions is a big issue, because employers do not take kindly to time taken off for maternity leave. This perhaps, more than anything, affects promotions and advancement in the profession (Appendix A.3-Profile of Alice).

## 5.5 Recommendations For Policy-Making and Future Research

The results of this study suggest that the home environment, parental encouragement, the type of school a girl attended and the experience of science a girl receives in school impacts very much on her decision to choose science as a career. It is

important then to develop strategies that will improve both the affective and knowledge outcomes of science for female students in Ghanaian schools. The following suggestions for policy planning and future research come out of the present study.

1. Even at the kindergarten girls should be given the opportunities to experience the challenges to scientific inquiries that other children from more privileged homes experience. Since early socialization has played such an important part in the development of science interest in most of our respondents, parents can be highly instrumental in helping females develop interest in science at the very early stages of their socialization process. The effect of this early socialization is seen in the impact that the educational levels and science occupations had on the career aspirations and achievement in science of the respondents in this study. It is recommended that this parent-child relationship can be exploited, not only for the privileged few who have parents in science professions, but most importantly for children who lack such parents. There should be a government-society support in creating a conducive school-home learning environment for children of all social classes.

2. There should be a national campaign to educate the adults about the tremendous influence they have on students' career decision making. This campaign must stress the advantages of females entering into these non-traditional careers, especially in terms of the availability of jobs and the higher pay. In the light of this the annual Science, Technology and Mathematics Education (STME) clinic for girls should be expanded to include sessions for parents, teachers and counselors.

3. Teachers, counselors and educational personnel should be encouraged to target female students who show the aptitude and recruit them for science careers at the early stages of their educational career. That is, teachers should be pro-active rather than finding remedial solutions to the under-achievement to female students in science.
4. Since there is such a lack of proper guidance services in the secondary school, it is recommended that both educational institutions and private agencies like research institutions and firms should join forces in strengthening career counseling resources in the secondary schools. This should be a process taking place throughout the life of the student in the secondary school. Consequently, professional counselors should be trained and employed into the educational system.
5. In most secondary school science teaching and learning, both teachers and students rely heavily on textbooks (since most laboratories are poorly equipped) which are written in English. But since English is the second language for all Ghanaian students, there is the need to improve the teaching and learning of the English language.
6. There is the need to encourage more women to take up science teaching, especially in physics and chemistry.

A number of unexpected findings emerged in this study which raises further research questions:

- There is the need for further research on students' understanding of the nature of science as it is taught in schools. Is the present science curriculum relevant to the Ghanaian student in his social and cultural context? Can the Ghanaian student understand science the same way as his/her American or European counterpart? Since most of the textbooks used in Ghanaian secondary schools reflect American or European situations, being written and imported from these countries. Admittedly, science is a universal concept, but the needs of different cultures and societies are different. Hence, the Ghanaian science curricula must be made to reflect the emerging needs of the Ghanaian society.
- There is the need for research on the socialization process of children who later choose a science career to determine how science interest is generated in them during the early stages of their educational careers.
- This study has shown the role some teachers played in determining which student would be capable of achieving in school science. While in theory most teachers believe in a democratic classroom where students make unfettered career decisions, in practice, math and science teachers have not reflected this belief. There is the need to investigate how the power that the teacher wields in the classroom help to reinforce traditional behaviors and occupational plans of women.
- This study also revealed the need for further study on how the gender of the teacher affects his/her beliefs about and behavior towards female students; and how these teacher behaviors and beliefs affects students' learning behaviors and achievements. This of course, calls into question a study on the whole issue of curriculum and teachers' pedagogical styles.

A Final Thought

Ghana, in its history and tradition has always, in some sense, been connected to other countries in the world – through the exchange of goods and services, travel, missionary activities and sharing of ideas. As the world becomes even smaller through improved information technology and faster means of travelling, it has become essential that those citizens who would live most of their adult lives in the twenty-first century be given the opportunities and tools which would enable them function effectively in a world which is becoming increasingly smaller. These citizens, irrespective of gender or social class, must be equipped with the attitudes, knowledge and skills necessary to deal with the vicissitudes of their world in the next century. Thus the obvious waste of the talents of women for the development of scientific careers, brought about by cultural norms about gender roles, both in society and academia, that marginalizes women in the scientific and technological fields, must be identified and curtailed. This is what this study has attempted to do.

A special attention must be given to the teaching of science and math, starting from the early years of the child's education. This has become imperative in view of the changes occurring in the field of science and technology in most countries. Also, in the educational system in the country, science and math have, for a very long time, been presented more as a subject that one can choose to ignore if he or she wishes. As the Deputy Minister of Education, Kwabena Kyere (1998) said during the opening of the 1998 Science, Technology and Mathematics Education (STME) clinic at Bolgatanga,

> Gone are the days when science, technology and math have been considered merely as subjects to be taught and learnt at school. These subjects go beyond the school system. We meet them in every aspect of our lives. A good knowledge in science and its application, which is

> known as technology, has greatly contributed to the rapid modernization of the world today. Our under-development, the apparent lack of progress and ability to harness and utilize our physical resources and talents for our own benefit with its consequent poverty, is attributed to our failure to see science beyond the activities of the classroom (p. 30).

Teachers, even in pre-school, should be able to make the teaching of science interesting and relevant to the children by engaging them in hands-on activities which are relevant to their daily life. If Ghana is to survive as a nation in a world that is rapidly changing due to modern technology, we cannot afford to marginalize any section of our citizenry from the fields of science and technology by any artificial barriers.

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# APPENDIX A

## A.1 Profile of Josephine

My name is Harriette. I am 41 years old, married with two sons. I come from a family of six on my mother's side and eighteen on my father's side. That is, my father had four children with my mother, and went on to have twelve other children with other women. My parents separated when I was six years old. I lived with my mother for most part of my childhood. My mother was a housewife and a seamstress, and was therefore financially dependent on my father. As a result of what I saw my mother go through, I made up my mind never to be so dependent on another person to the extent that my mother did. This is what had driven me all my life and still drives me today.

I studied and obtained my GCE ordinary level (O'level) certificate at the Aburi Girls' secondary school and my Advanced Level certificate at the Wesley Girls' High School. I gained admission into the University of Science and Technology to study electrical and electronic engineering. Some of my male friends who were at the time also in the engineering program made attempts to convince me to change my program because the engineering program was difficult. My father also asked me to change to pharmacy, which was my second choice because he thought that was more feminine. All attempts to dissuade me had failed, because my choice of profession was driven by my love of applied math.

There were 120 males in my class, and I was the only female. In fact there were only three females in the whole engineering faculty of about 500 students the year I entered the university. The overwhelming male presence did not bother me at all. I was lucky to have found a mentor, Prof. Kwame, the then Dean of the Engineering faculty.

His continued encouragement played a major role in my ability to successfully complete my program. I served my two-year National Service with the Volta River Authority (VRA), and was offered a permanent employment in that establishment. I got married to Jabesh, a mechanical engineer. I quiet well remember that my mother was always concerned that my career would make it difficult for me to find a suitable marriage partner.

I have not been able to develop myself, career sense, as I would have loved to do due to the demands of raising a family. But hey, I have no regrets; it's been worth every while. I have learnt in my short life that there 'are no free lunches.' Even though I sacrificed my career, raising a family has been rewarding in its own way.

I am presently a Principal Planning Engineer with the Transmission Systems Department of the VRA, the main electrical power generation and transmission utility in Ghana. I have worked in various capacities during my stay with VRA. I worked as a design engineer for two years, a protection and control engineer for three years. I am a member of the council for the Ghana Institution of Engineers (Ghie) and the chairperson for the newly created network, WINE. WINE is a network of Women in Engineering within the Ghie that seeks to promote the welfare of the 'girl child' and encourage those with the aptitude and interest to study engineering.

### A.2 Profile of Dinah

I am the first of three children of my parents. My father is a graduate of the University of Ghana who majored in geography. After teaching in a number of secondary schools he retired and is now a consultant for Book Development. My mother, also retired was a

teacher with teachers' training certificate. I went to Wesley Girls' High School for my secondary education. In addition to my science subjects, I offered geography, French and Literature in English at the Ordinary Level Examination. My dream was to study advanced physics, chemistry and biology in the sixth form, and hopefully become a pharmacist in the future. My hopes were dashed when my in the O'Level I obtained a grade 7 in additional mathematics, which meant I would not be accepted into the science program in the sixth form. I was advised to take economics, geography and French, which I did. I have no regrets opting for the arts subjects since I am currently pursuing a career in Marketing with a reputable multinational company, which manufactures consumer goods.

### A.3 Profile of Alice

I am the second child of my parents. My father was a civil engineer who worked for the Ghana Water and Sewerage Corporation till his retirement. My mother had only a primary education. I started my secondary education at St. Louis Secondary School, and after my ordinary level examinations went to Wesley Girls' High School for my advanced level studies. It is interesting to point out that for the first month of my sixth form education, I opted for biology till the volume of notes pushed me to change to mathematics. At Wesley Girls' High School the interaction between students and teachers was extremely healthy with fellow students going out of their way to make sure that I understood everything and helping out when there was a difficulty in any subject.

I was offered admission to study chemical engineering at the university. I was the only female in a class of one hundred and seventy-five (175). After struggling with

engineering drawing in my first year of studies, my head of department advised me to change to some other program more feminine like biochemistry or computer science because I failed two subjects in the first year. However, there were men in the same class who also failed in as many subjects, and yet they were not asked to change their program because they failed. My colleagues on the other hand were very supportive and encouraged me a lot. In my third year at the university, most of the faculty changed their attitude toward me when they realized I was determined to qualify as an engineer.

After graduation, I served at Lever Brothers for my National Service and was given a permanent employment after the two years of service. I have worked in various capacities as manager responsible for glycerin production, refining of oils for margarine production, development and research, and now as quality assurance manager. After five years in industry I took the engineering proficiency examination organized by the Ghana Institute of Engineers. Now I am a full member of the institute. In our factory there are about forty qualified engineers from various engineering disciplines.

Parenthood for a female engineer, and I suppose for most of the other presumably male dominated professions is a big issue because employers do not take kindly to time taken off for maternity leave. This perhaps more than anything else affects promotions and advancement in the profession. Marriage was not an issue for me personally except that because of my stature: tall and big, most men seemed afraid to propose to me for a long time. Also the fact that I was a woman in a male dominated profession put them off. However, I have been married since the last five years and had been blessed with a wonderful little boy.

Personally I enjoy being in a predominantly male career because people really look out for you and want to know who you are, the attention and protection I invariably get makes me think all men engineers are ordinary, while their female counterparts are special beings.

A.4 Profile of Lynda

I had always wanted to pursue a career in science, but my physics was so bad I had to give up. It was my desire to combine biology and chemistry with geography, but as you know that combination was not allowed. My brother who was a lawyer thought that since my ordinary level examination results in the arts subjects were very good any further educational pursuits should be in the arts. The problem I had with the arts subjects was that I needed a lot of time to read and for a slow reader like me, I could never keep up with the volume of reading and assignments in order for me to pass my tests. Further I never had time for extra curricular activities. My desire to pursue a career in the sciences had never eluded me. When I came here (meaning the USA) I saw the opportunity right knocking at the door, so I took advantage of it. I took nursing, but I did not know that it was that difficult. Despite the difficulty I am happy because at long last my heart's desires had been met.

My brother was surprised to learn that I had gone back to a science program. He thought that was a bold and tough decision. The surprising thing is that he is encouraging me this time in this program. My husband had always been so supportive. As for my children, I know I would not have as much time for them as I would have I gone into teaching. But my thought about it is that they are no longer children. They are gradually learning how

to take care of themselves. The main reason I changed again to a science career was the opportunities attached to it in relation to accessibility of jobs. There are also wide ranges of areas where one can work and there is so much prestige attached to the work.

A. 5 Profile of Comfort

I am Felicia, married with three children. I come from a family of seven. I also have four half-siblings on my father's side. My father worked as a factory driver till he retired and operated his own transport business. My mother was a trader. In my elementary school (which was an all-girls' school), the teachers went out of their way to show how important the education of women was. The following quotation by Dr. Aggrey was boldly written in front of our assembly hall, "if you educate a man, you educate an individual; if you educate a woman, you educate a nation'. Though I passed the Common Entrance examinations in two conservative years, I was not allowed to enter the secondary school on both occasions. Apart from my father's poor financial situation, his elder brother advised him not to waste his money on the education of a girl who will eventually end up marrying. However, one of my aunts secured a place for me at Accra High School. I was very good at geography, literature, biology and physics, but weak in chemistry and math. My chemistry and math teachers were not encouraging, and did not have patience with us girls who found the subjects difficult.

I had wanted to enroll in the medical school, but my GCE ordinary level results were not good enough to give me an admission into the sixth form. Upon the advice of my principal, I sought admission at the specialist teacher training college to be trained as a home science teacher. After graduation I taught in various places till I was given a

teaching position at the Specialist Teacher Training College (now the University College of Winneba). After four years of teaching in this college I was offered a Ghana government scholarship to study at the Louisiana State University in the USA. I completed my Ph.D in 1987. Though I faced a lot of opposition from my uncles and my husband's family with respect to my travelling outside to further my education, my husband was very supportive. The opposition to my further studies was about the fact that it was the man who had to leave his wife at home and travel, and not the other way round.

# APPENDIX B

## QUESTIONNAIRE

1. Name of University: ----------
2. Course of study: ----------
3. Year of study ----------
4. Which secondary school(s) did you attend? ----------
5. Please indicate in the columns provided whether the secondary school(s) you attended during the years indicated was single-sex or coed.

| FORM | 1 -5 | 6 -7 | S S S |
|---|---|---|---|
| SINGLE SEX | | | |
| CO-ED | | | |

6.

| | Highest educational level attained by mother | Highest educational level attained by father |
|---|---|---|
| None | | |
| Primary | | |
| Commercial/vocational | | |
| Secondary | | |
| Post-Secondary | | |
| University | | |
| Post-graduate | | |
| | | |

7. Mother's occupation *(even if retired)*: ----------
   Father's occupation (*even if retired*): ----------

8. For the following questions, please circle the response, which best applies.

   (a) ***For science students***:

At what stage in your education did your intention concerning a science career course first emerge?

   i. Junior secondary
   ii. Secondary/senior secondary
   iii. Other (please specify).

(b) During this period of your education....

| | | |
|---|---|---|
| i. Did you find science enjoyable? | Yes | No |
| ii. Did the science teachers make science lessons interesting? | Yes | No |
| iii. Did you find science a difficult subject? | Yes | No |
| iv. Did you find science difficult when it involved calculation? | Yes | No |
| v. Did you find science difficult when it involved doing laboratory experiments? | Yes | No |

Did you find any particular science topic(s) abstract in nature? [ie. Physics, chemistry, or biology, or math] (Yes). (No).

If Yes, which topic(s)----------

9. For non-science students:

For the following questions, please circle the response which best applies.

(a). Did you ever consider pursuing a science career? (Yes) (No)

(b). If yes, at which stage in your education did you lose interest in pursuing a career in science?

i. junior secondary ii. Secondary/senior secondary

(c) Before deciding against pursing a science career (if you ever thought about it)

| | | |
|---|---|---|
| i. Did you find science enjoyable? | Yes | No |
| ii. Did the science teachers make science lessons interesting? | Yes | No |
| iii. Did you find science a difficult subject? | Yes | No |
| iv. Did you find science difficult when it involved calculation? | Yes | No |
| v. Did you find science difficult when it involved doing laboratory experiments? | Yes | No |

Did you find any science subject(s) abstract? (Yes). (No).

If Yes, which subject(s)----------

d. At what point in your education did you switch from studies in science to arts or humanities? ----------

e. Briefly give some reasons for this switch:----------

---

---

10. What was the gender of your science teachers in the secondary/senior secondary school?

i. mostly men ii. mostly women iii. equally men and women iv. all women. v. all men.

11. **For science students:**

How would you rate the importance of the following influences of your choice of science as a career.

| | Extremely Important | Very important | Somewhat important | Barely important | Not important at all |
|---|---|---|---|---|---|
| Ability in math | | | | | |
| Ability in biology | | | | | |
| Ability in physics and chemistry | | | | | |
| Career aspiration | | | | | |
| Other (please state) ---------- | | | | | |

(b). Which of the following best describes your reasons for pursuing a science career

i. ability in studying the subject area of science
ii. interest in studying the subject area of science
iii. career aspiration
iv. other (please specify) ----------

12. (a) ***For non-science students***:
How would you rate the importance of the following influences on your decision not to pursue science as a career.

| | Extremely Important | Very Important | Somewhat important | Barely important | Not at all important |
|---|---|---|---|---|---|
| Ability in math. | | | | | |
| Ability in biology | | | | | |
| Ability in physics and chemistry | | | | | |
| Career aspiration | | | | | |
| Other (please state) ---------- | | | | | |

(b). Which of the following best describes your reasons for not pursuing a science career
- v. ability in studying the subjects
- vi. interest in studying the subjects
- vii. career aspiration in another field
- viii. other (please specify) ----------

13. **For both science and non-science students**
How important was the influence of the following people on your decision to pursue (or not to pursue) science as a career.

| | Extremely Important | Very important | Somewhat important | Barely important | Not at all important |
|---|---|---|---|---|---|
| Mother | | | | | |
| Father | | | | | |
| Siblings | | | | | |
| Family member (please state) | | | | | |
| Peers | | | | | |
| Elementary /jss teacher | | | | | |
| Secondary/ SSS teacher | | | | | |
| Others (please state) ---------- | | | | | |

14. ***For science students***
How would you rate the influence of the following in your school on your decision to pursue a career in science:

| | Extremely Important | Very important | Somewhat important | Barely important | Not important |
|---|---|---|---|---|---|
| Friends | | | | | |
| Good marks in sci./math | | | | | |
| Science teachers | | | | | |
| Math teachers | | | | | |
| Interest in subject | | | | | |
| Career counselor | | | | | |
| Other (please state) ---------- ---------- | | | | | |

Did your school have a counselor? i. Yes ii. No
Did a counselor or teacher ever give you the impression that you would do well or poorly in science? i. Yes ii. No
Please briefly explain: ----------
---

15. ***For non-science students***:
How would you rate the influence of the following in your school on your decision not to pursue science as a career course.

| | Extremely Important | Very Important | Somewhat important | Barely important | Not important at all |
|---|---|---|---|---|---|
| Friends | | | | | |
| Poor marks in sci./math | | | | | |
| Sci. teachers | | | | | |
| Math teachers | | | | | |
| Lack of interest in subject | | | | | |
| Career counselor | | | | | |
| Other | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| (please state) _____ | | | | | |

Did your school have a counselor? i. Yes ii. No

b. Did a counselor or teacher ever give you the impression that you would do well or poorly in science? i. Yes ii. No

Please briefly explain: _____

_____

_____

16. a. How important a role did the thought of marriage and parenthood play in your choice of career program?

i. extremely important
ii. very important
iii. somewhat important
iv. barely important
v. not important at all

b. Please briefly explain: _____

_____

_____

_____

_____

_____

_____

**Table 1`**
**Distribution of Highest Educational Level Achieved by Parents**

| | Highest Educational Level Attained by Mother | | | | Highest Educational Level Attained by Father | | | |
|---|---|---|---|---|---|---|---|---|
| | Science | | Non-Science | | Science | | Non-Science | |
| | N | % | N | % | N | % | N | % |
| None | 2 | 2.08 | 15 | 17.67 | | | | |
| Primary | 2 | 2.08 | 8 | 9.41 | | | | |
| Comm/Voc | 17 | 17.71 | 17 | 20 | 5 | 5.21 | 11 | 12.94 |
| Secondary | 14 | 14.58 | 9 | 10.59 | 10 | 10.42 | 25 | 29.41 |
| Post-Sec | 29 | 30.21 | 20 | 23.53 | 18 | 18.75 | 23 | 27.04 |
| First Degree | 25 | 26.04 | 13 | 15.29 | 34 | 35.42 | 17 | 20.00 |
| Graduate | 7 | 7.29 | 3 | 3.53 | 29 | 30.20 | 9 | 10.59 |
| Total | 96 | 100 | 85 | 100 | 96 | 100 | 85 | 100 |

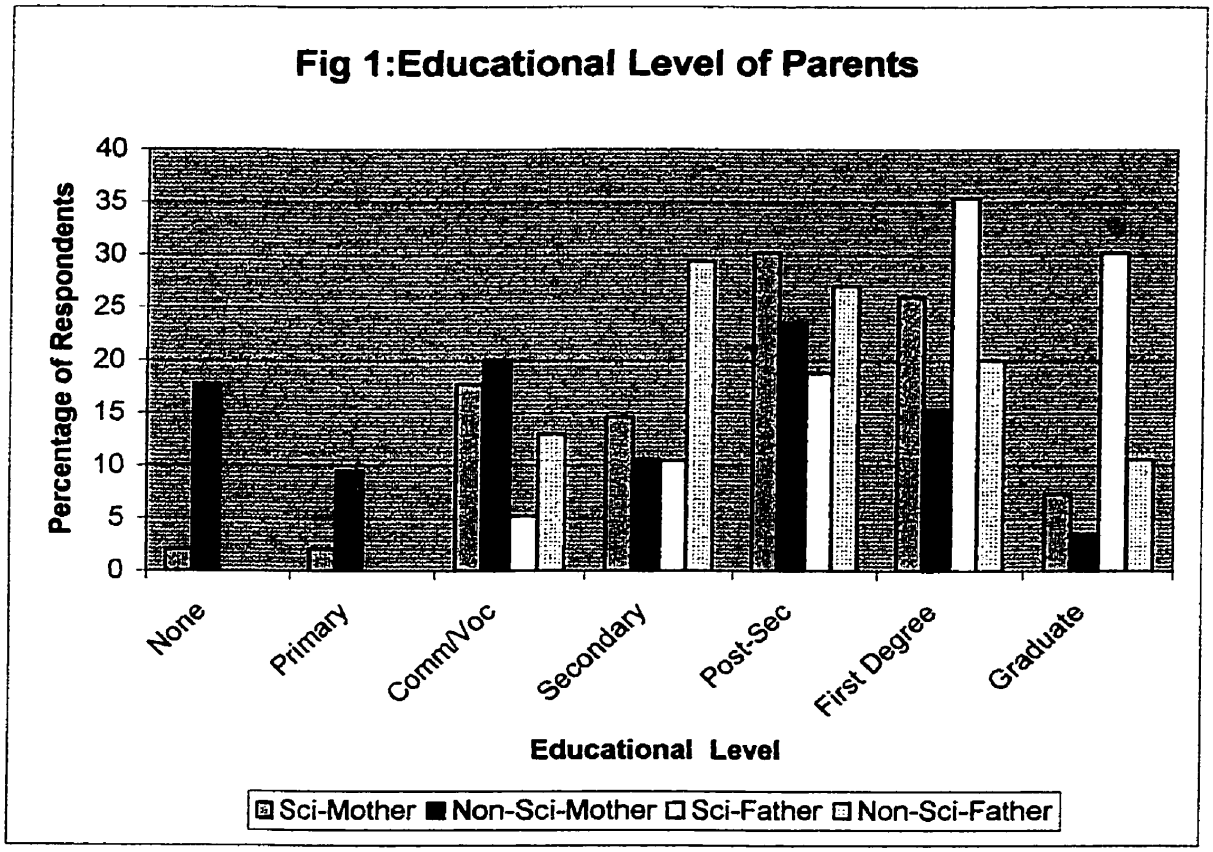

**Table 2**
**Type of School**

| | Science | | Non-Science | |
|---|---|---|---|---|
| | N | % | N | % |
| **Single-Sex Sixth Form** | 23 | 23.96 | 26 | 30.59 |
| **Single-Sex SSS** | 40 | 41.67 | 15 | 17.65 |
| **Co-Ed. Sixth Form** | 22 | 22.91 | 33 | 38.82 |
| **Co-Ed. SSS** | 11 | 11.46 | 11 | 12.94 |
| **Total** | 96 | 100 | 85 | 100 |

Fig 2. Type of School Attended

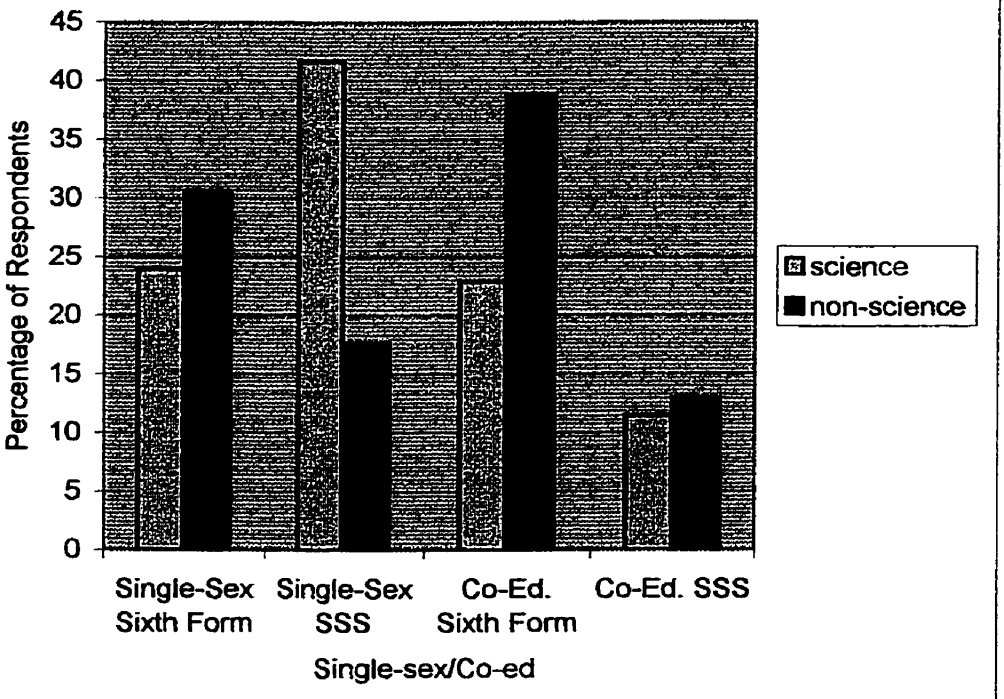

Table 2B:
School Type and Students in Physical Sciences and Engineering

| | Single-sex | | Co-Educational | | | |
|---|---|---|---|---|---|---|
| | N | % | N | % | Total | % |
| SSS | 6 | 25 | 2 | 18.18 | 8 | 22.86 |
| Sixth Form | 18 | 75 | 9 | 81.82 | 27 | 77.14 |

**TABLE 3:**
**Occupation of Parents by Field**

| | Mother | | | | Father | | | |
|---|---|---|---|---|---|---|---|---|
| | Science | | Non-Science | | Science | | Non-Science | |
| | N | % | N | % | N | % | N | % |
| Science | 31 | 33.70 | 17 | 21.25 | 40 | 42.55 | 12 | 14.46 |
| Non-Science | 52 | 56.52 | 49 | 61.17 | 43 | 45.75 | 52 | 62.65 |
| Other | 9 | 9.78 | 14 | 17.5 | 11 | 11.70 | 19 | 22.89 |
| Total | 92 | 100 | 80 | 100 | 94 | 100 | 83 | 100 |

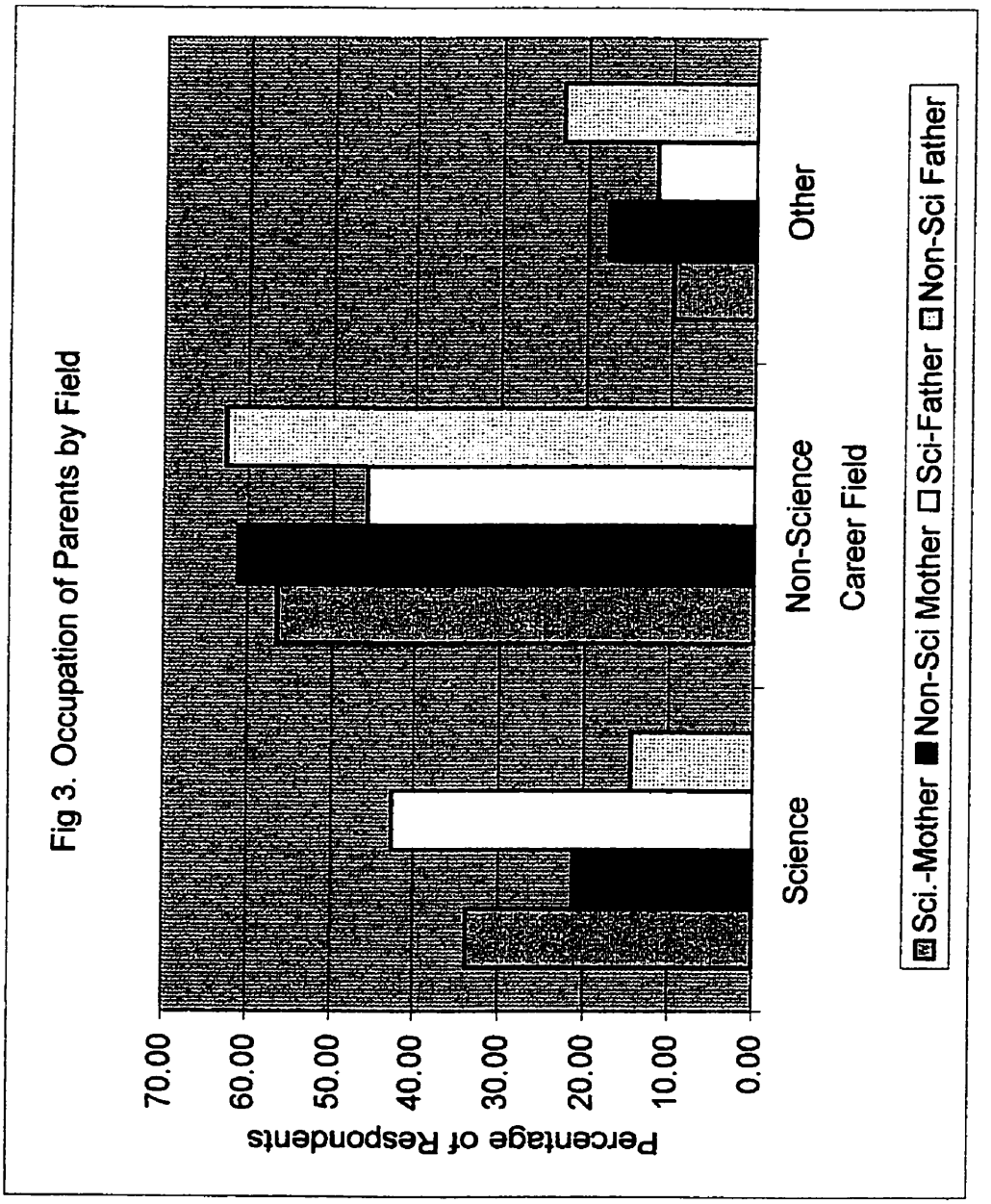
Fig 3. Occupation of Parents by Field
Percentage of Respondents
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Science
Non-Science
Other
Career Field
Sci.-Mother
Non-Sci Mother
Sci-Father
Non-Sci Father

**Table 4A:**
**Science Students' Perception of Science and Teachers**

| | Yes | | No | |
|---|---|---|---|---|
| | N | % | N | % |
| Subject enjoyable | 88 | 92.63 | 13.00 | 26.53 |
| Tchrs made it interesting | 69 | 72.63 | 8.00 | 16.33 |
| Subject difficult | 21 | 22.34 | 43.00 | 87.76 |
| Difficult with calculation | 38 | 40.00 | 46.00 | 93.88 |
| Difficult with Lab. Work | 11 | 11.70 | 47.00 | 95.92 |

**Table 4B:**
**Non-Science Students' Conception of School Science**

| | Yes | | | | No | | | |
|---|---|---|---|---|---|---|---|---|
| | Considered | | Never Did | | Considered | | Never Did | |
| | N | % | N | % | N | % | N | % |
| Subject enjoyable | 24 | 66.67 | 13.00 | 26.53 | 12 | 33.33 | 36 | 73.47 |
| Tchrs made it interesting | 11 | 30.56 | 8.00 | 16.33 | 25 | 69.44 | 41 | 83.67 |
| Subject difficult | 27 | 75.00 | 43.00 | 87.76 | 9 | 25.00 | 6 | 12.24 |
| Difficult with calculation | 32 | 88.89 | 46.00 | 93.88 | 4 | 11.11 | 3 | 6.12 |
| Difficult with Lab. Work | 21 | 58.33 | 47.00 | 95.92 | 15 | 41.67 | 2 | 4.08 |

**Table 4C**
**Comparison of Science, Arts and Considered Students**

| | Science | | Humanities | | Considered | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Subject enjoyable | 88 | 92.63 | 13 | 26.53 | 24 | 66.67 |
| Tchrs made it interesting | 69 | 72.63 | 8 | 16.33 | 11 | 30.56 |
| Subject difficult | 21 | 22.34 | 43 | 87.76 | 27 | 75 |
| Difficult with calculation | 38 | 40 | 46 | 93.88 | 32 | 88.89 |
| Difficult with Lab. Work | 11 | 11.7 | 47 | 95.92 | 21 | 58.33 |

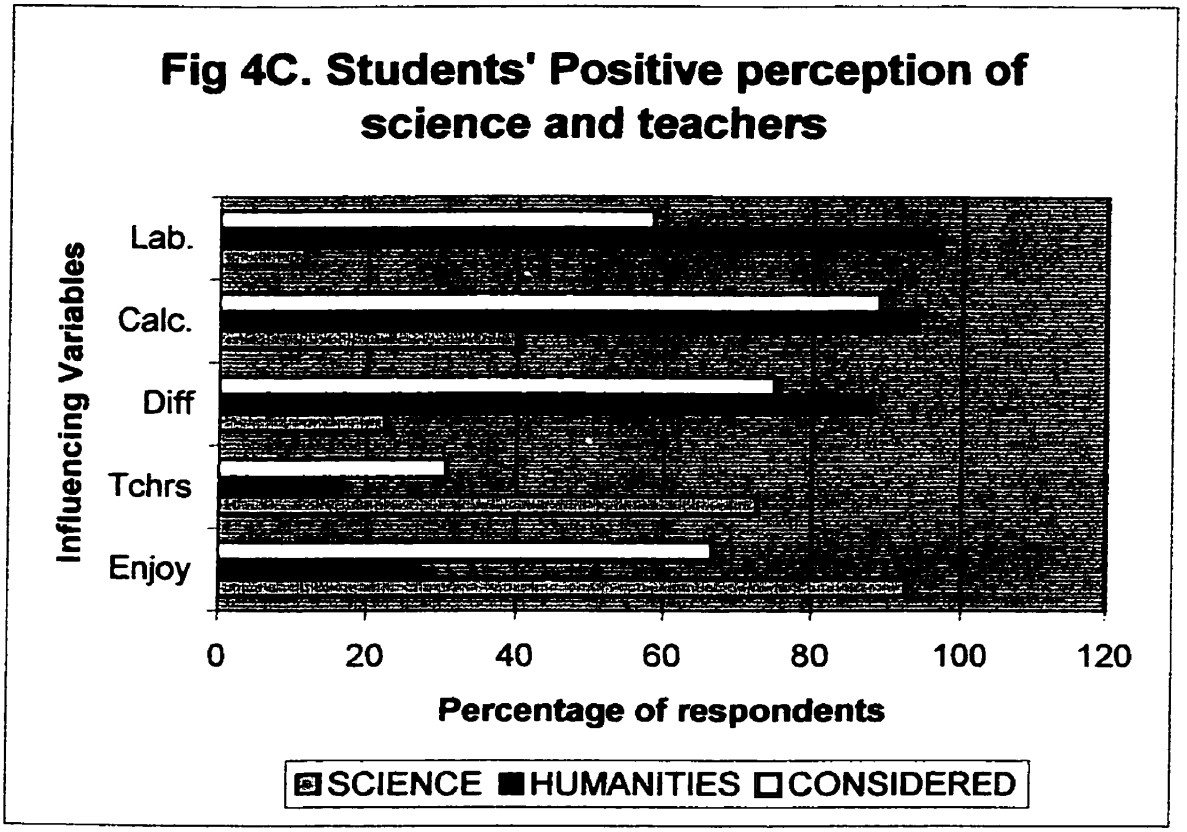
Fig 4C. Students' Positive perception of science and teachers
Influencing Variables
Lab.
Calc.
Diff
Tchrs
Enjoy
0
20
40
60
80
100
120
Percentage of respondents
SCIENCE
HUMANITIES
CONSIDERED

**Table 4D**
**Comparison of Science, Arts and Considered Students**

| | | Enjoy | Tchrs | Diff | Calc. | Lab. |
|---|---|---|---|---|---|---|
| Science | N | 88 | 69 | 21 | 38 | 11 |
| | % | 92.63 | 72.63 | 22.34 | 40 | 11.7 |
| Humanities | N | 13 | 8 | 43 | 46 | 47 |
| | % | 26.53 | 16.33 | 87.76 | 93.88 | 95.92 |
| Considered | N | 24 | 11 | 27 | 32 | 21 |
| | % | 66.67 | 30.56 | 75 | 88.89 | 58.33 |

Table 6A
Science: Effect of Science Subjects and Career on Choice of Program

| Level of Importance | Math | | Biology | | Phy/Chem | | Career | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| Extremely | 47 | 48.96 | 27 | 28.12 | 26 | 27.08 | 59 | 61.46 |
| Very | 30 | 31.25 | 25 | 26.04 | 34 | 35.42 | 26 | 27.08 |
| Somewhat | 19 | 19.79 | 5 | 5.21 | 30 | 31.25 | 11 | 19.46 |
| Barely | | | 28 | 29.17 | 6 | 6.25 | | |
| Not at all | | | 11 | 11.46 | | | | |
| Total | 96 | 100 | 96 | 100 | 96 | 100 | 96 | 100 |

## Fig 6A. Science: Science Subjects on Choice

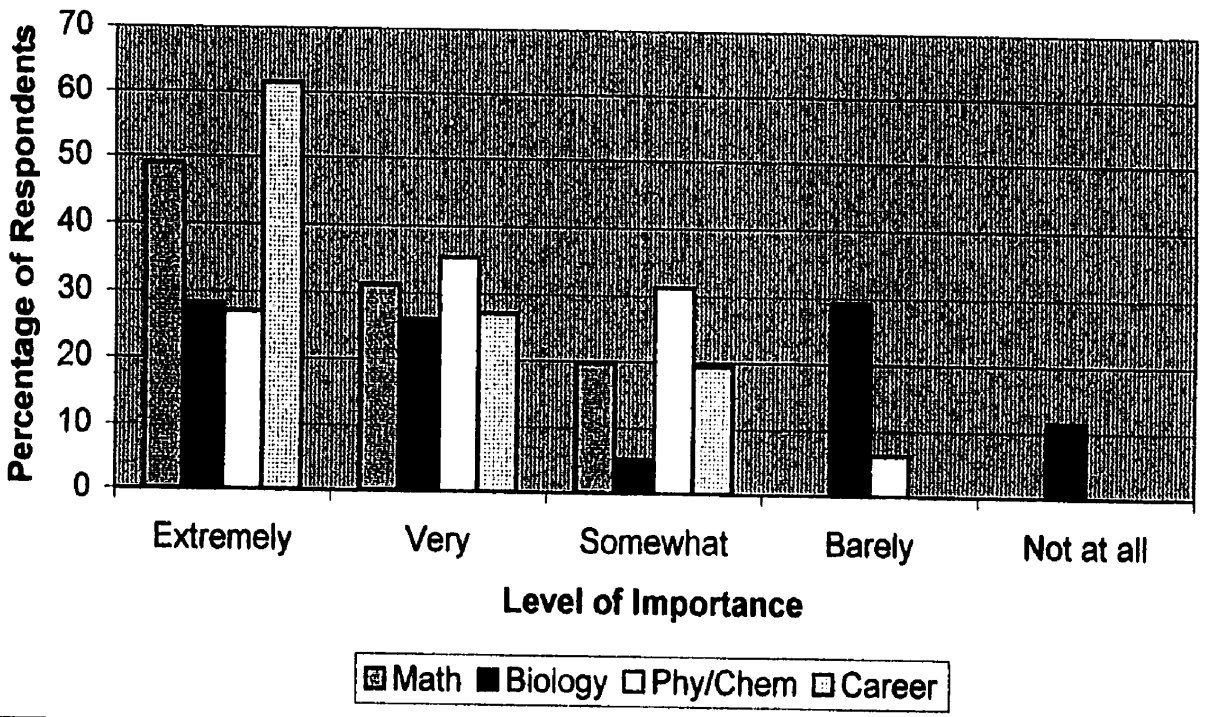

Table 6B
Non-Science. Effect of Science Subjects and Career on Choice of Program

| Level of Importance | Math | | Biology | | Phy/Chem | | Career | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| Extremely | 23 | 27.06 | 13 | 15.29 | 16 | 18.82 | 53 | 62.35 |
| Very | 36 | 42.35 | 15 | 17.65 | 28 | 32.94 | 17 | 20.00 |
| Somewhat | 21 | 24.71 | 7 | 8.23 | 35 | 41.18 | 13 | 15.30 |
| Barely | 5 | 5.88 | 32 | 37.65 | 6 | 7.06 | | |
| Not at all | | | 18 | 21.18 | | | | |
| Total | 85 | 100 | 85 | 100 | 85 | 100 | 85 | 100 |

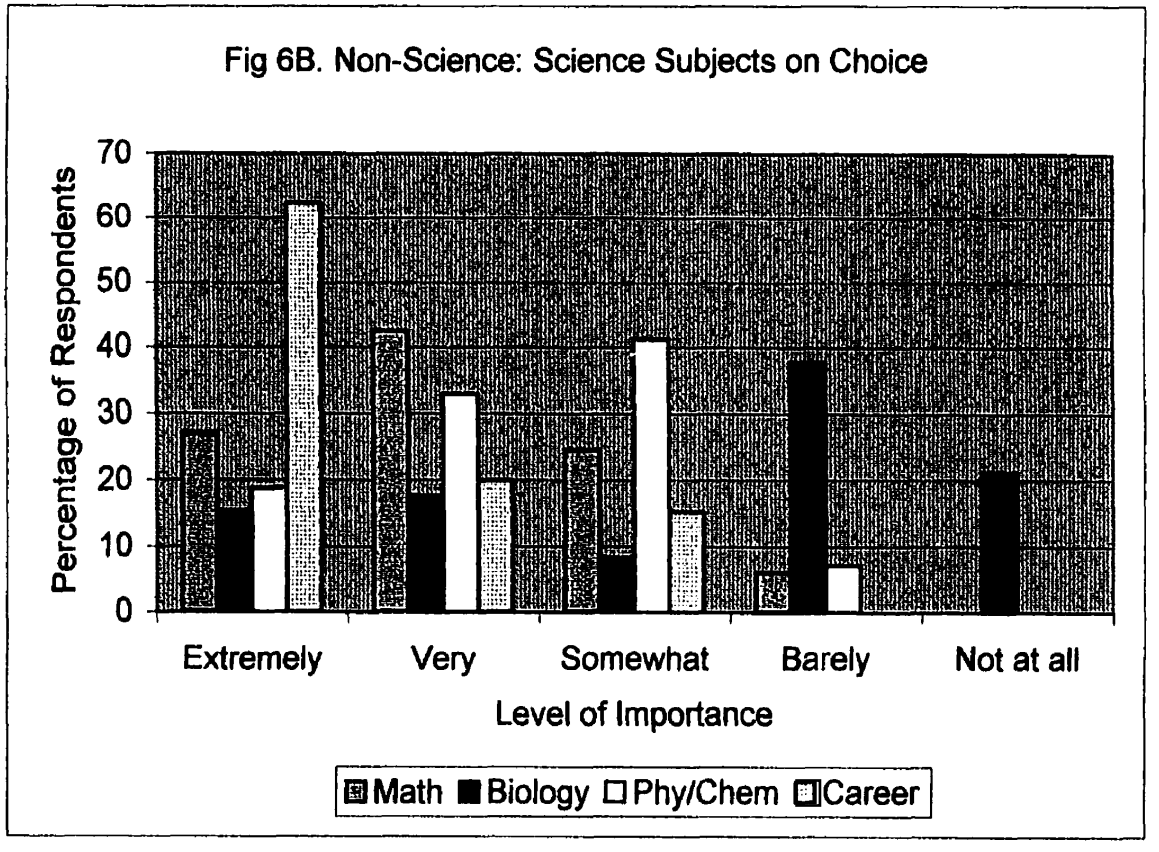
Fig 6B. Non-Science: Science Subjects on Choice
Percentage of Respondents
70
60
50
40
30
20
10
0
Extremely
Very
Somewhat
Barely
Not at all
Level of Importance
Math
Biology
Phy/Chem
Career

**Table 7:**
**Some Reasons for Choosing Program**

| | Science | | Non-Science | |
|---|---|---|---|---|
| | N | % | N | % |
| Ability in Studying Sci. | 19 | 19.79 | 5 | 5.88 |
| Interest in Studying Sci. | 26 | 27.08 | 17 | 20.00 |
| Career Aspiration | 51 | 53.13 | 63 | 74.12 |
| Total | 96 | 100 | 85 | 100 |

Table 8A-1
Science: Home Influence on Choice of Program

| Level of Importance | Mother | | Father | | Siblings | | Family Member | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| Extremely | 24 | 25.00 | 19 | 19.79 | | | 2 | 2.08 |
| Very | 36 | 37.50 | 27 | 28.13 | 9 | 9.38 | 4 | 4.17 |
| Somewhat | 19 | 19.79 | 25 | 26.04 | 13 | 13.54 | 11 | 11.46 |
| Barely | 12 | 12.50 | 10 | 10.42 | 32 | 33.33 | 9 | 9.38 |
| Not at all | 5 | 5.21 | 15 | 15.62 | 42 | 43.75 | 70 | 72.92 |
| Total | 96 | 100 | 96 | 100 | 96 | 100 | 96 | 100 |

Fig 8A-1. Science: Home Influence on Choice

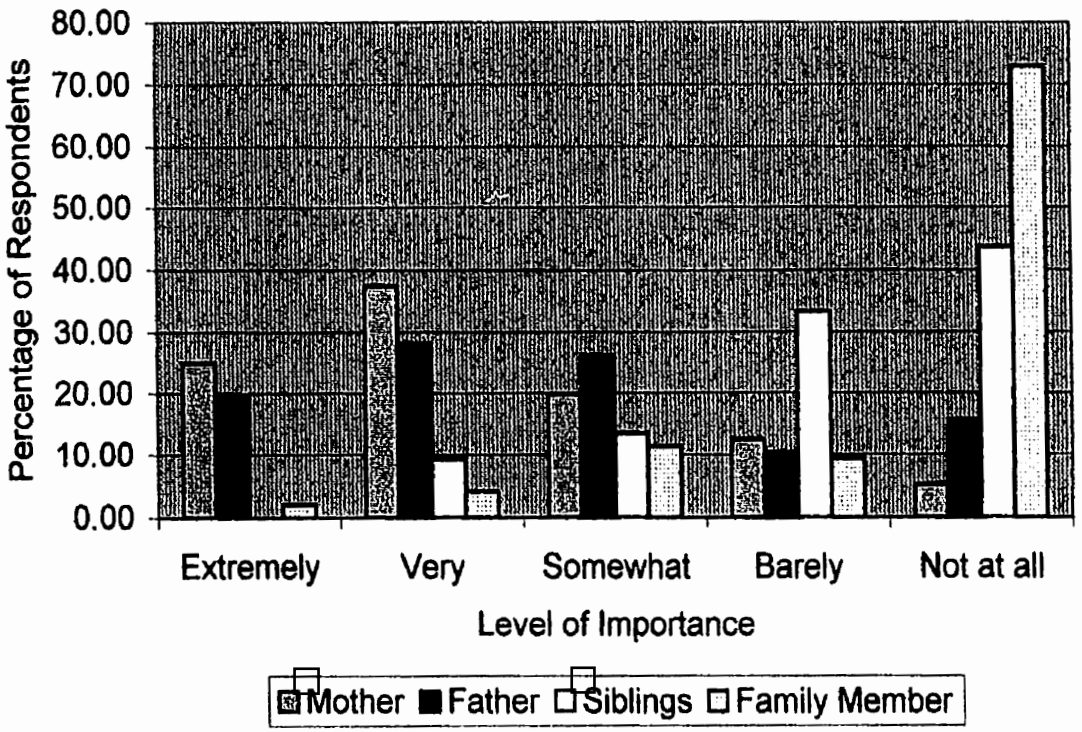

Table 8A-2
Science: Influence of People in School on Choice of Program

| Level of Importance | Peers | | Elem/JSS Teachers | | Secondary Teachers | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Extremely | | | 5 | 5.21 | 14 | 14.58 |
| Very | 6 | 6.25 | 12 | 12.50 | 21 | 21.88 |
| Somewhat | 17 | 17.71 | 18 | 18.75 | 30 | 31.25 |
| Barely | 27 | 28.12 | 42 | 43.75 | 18 | 18.75 |
| Not at all | 46 | 47.92 | 19 | 19.79 | 13 | 13.54 |
| Total | 96 | 100 | 96 | 100 | 96 | 100 |

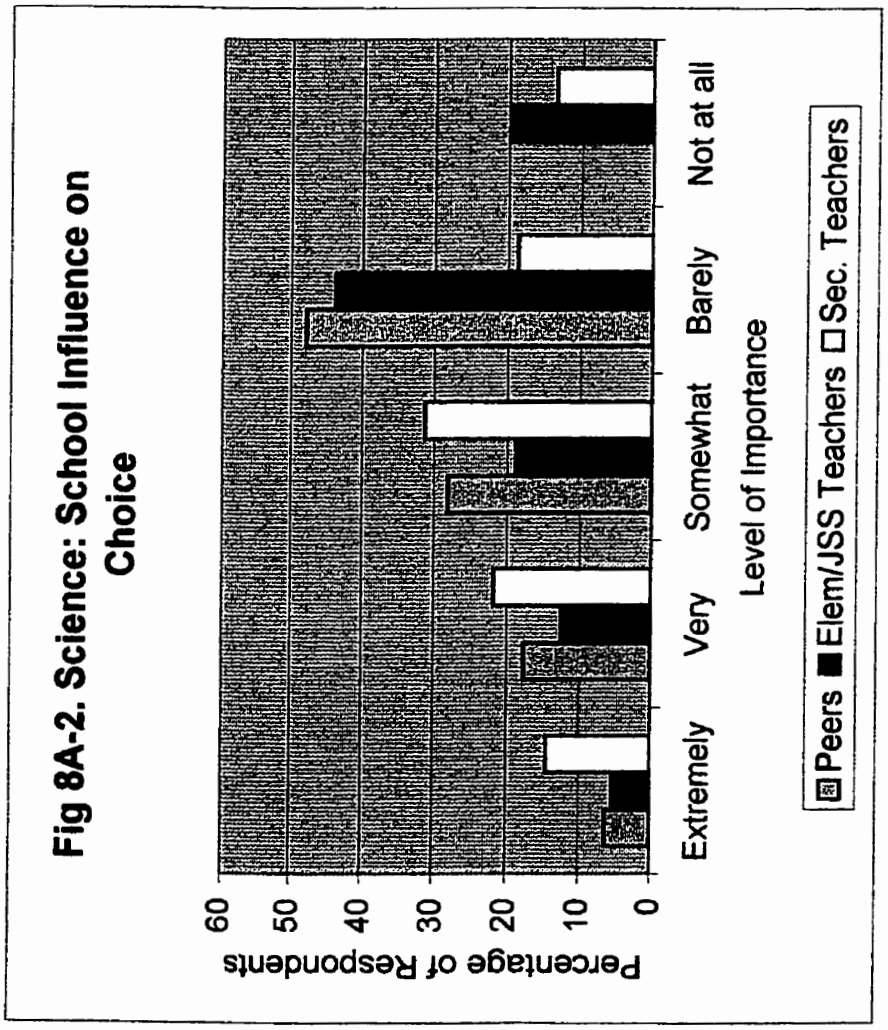

Table 8B-1
Non-Science: Home Influence on Choice of Program

| Level of | Mother | | Father | | Siblings | | Family Member | |
|---|---|---|---|---|---|---|---|---|
| Importance | N | % | N | % | N | % | N | % |
| Extremely | 9 | 10.59 | 13 | 15.29 | | | | |
| Very | 12 | 14.12 | 11 | 12.94 | 12 | 14.12 | | |
| Somewhat | 14 | 16.47 | 23 | 27.06 | 3 | 3.53 | | |
| Barely | 38 | 44.70 | 30 | 35.29 | 51 | 60.00 | | |
| Not at all | 12 | 14.12 | 8 | 9.41 | 19 | 22.35 | | |
| Total | 85 | 100 | 85 | 100 | 85 | 100 | | |

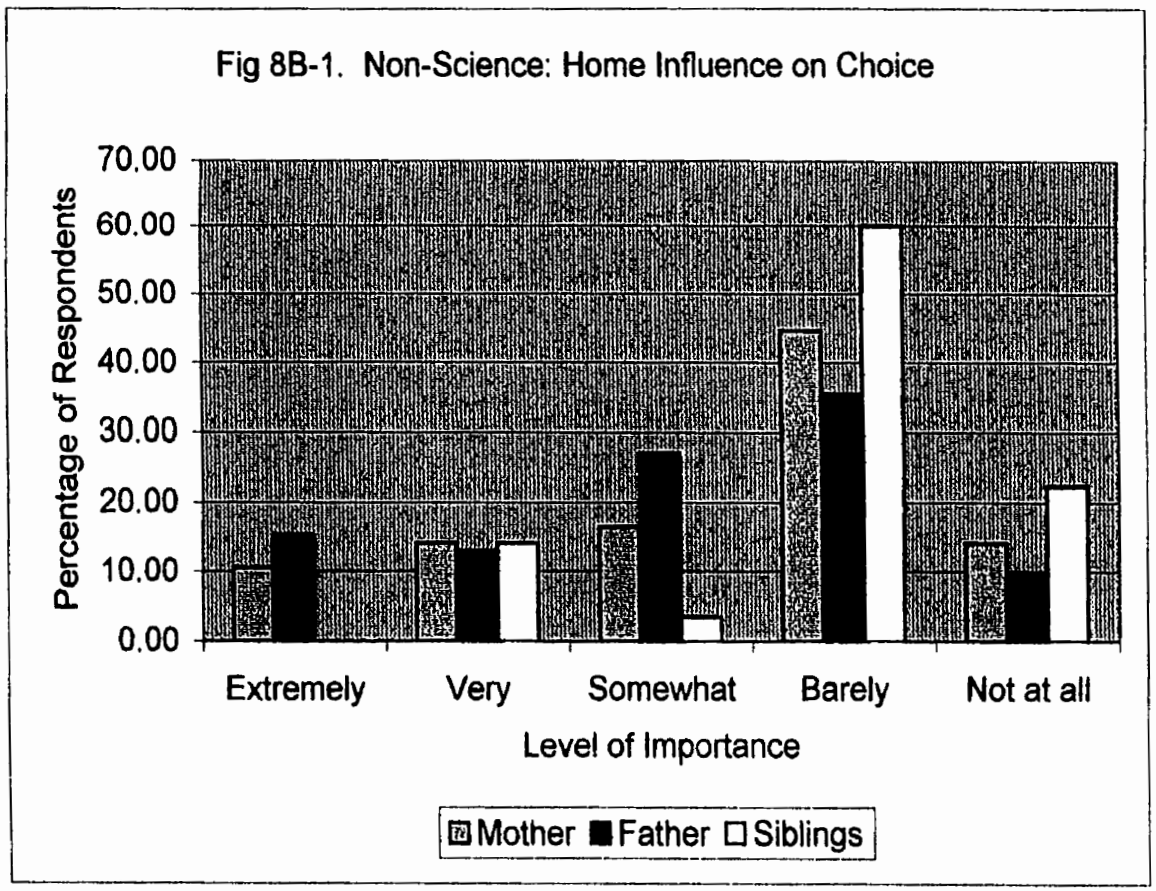
Fig 8B-1. Non-Science: Home Influence on Choice
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Percentage of Respondents
Extremely
Very
Somewhat
Barely
Not at all
Level of Importance
Mother
Father
Siblings

Table 8B-2
Non-Science: Influence of People in School on Choice of Program

| Level of Importance | Peers | | Elem/JSS Teachers | | Secondary Teachers | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Extremely | | | 2 | 2.35 | 9 | 10.59 |
| Very | | | 2 | 2.35 | 23 | 27.06 |
| Somewhat | 15 | 17.64 | 1 | 1.18 | 35 | 41.18 |
| Barely | 18 | 21.18 | 8 | 9.41 | 18 | 21.17 |
| Not at all | 52 | 61.18 | 72 | 84.71 | | |
| Total | 85 | 100 | 85 | 100 | 85 | 100 |

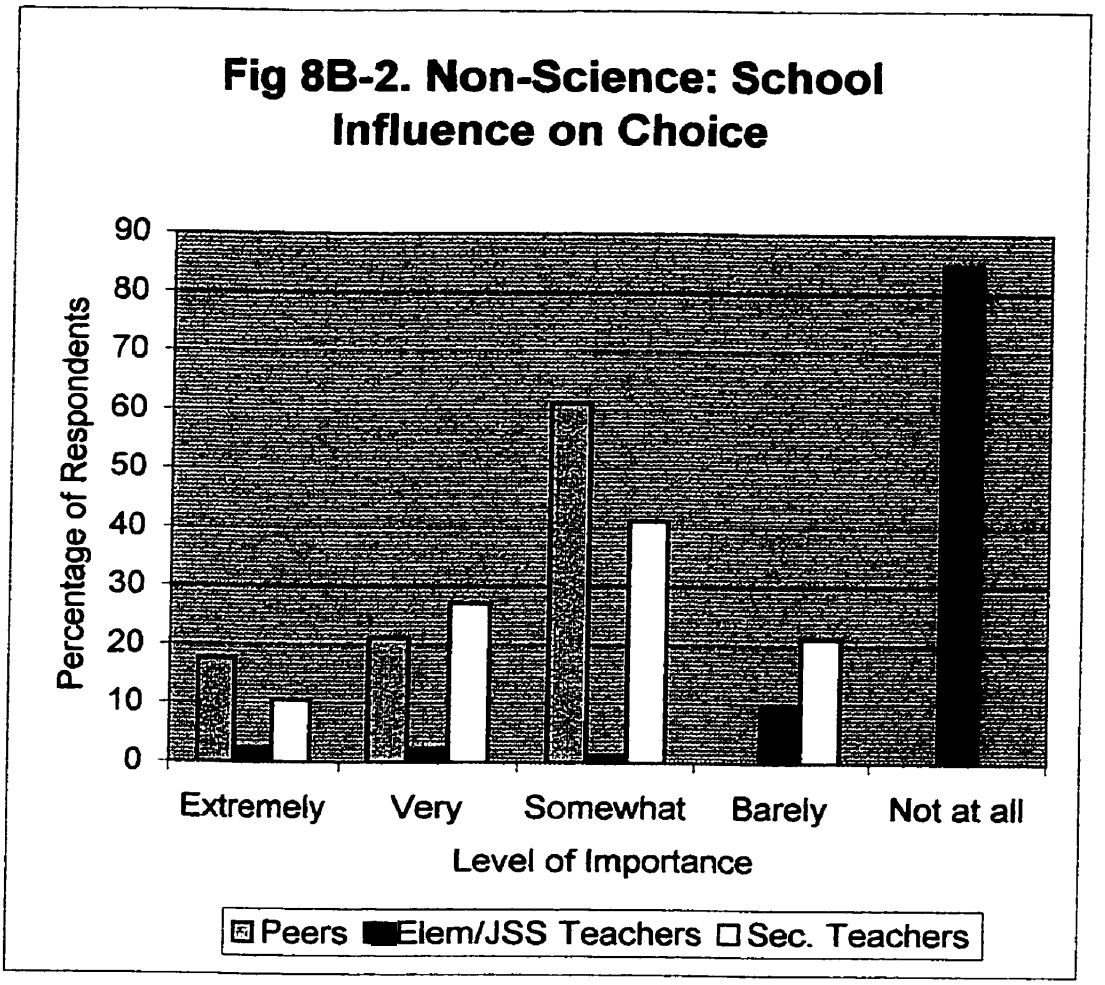
Fig 8B-2. Non-Science: School Influence on Choice
90
80
70
60
50
40
30
20
10
0
Percentage of Respondents
Extremely
Very
Somewhat
Barely
Not at all
Level of Importance
Peers
Elem/JSS Teachers
Sec. Teachers

Table 8C-1
Influence of Mothers on Choice of Program

| Level of Importance | Science | | Humanities | | Considered | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Extremely | 24 | 25 | 1 | 2.04 | 8 | 22.22 |
| Very | 36 | 37.5 | 2 | 4.08 | 10 | 27.78 |
| Somewhat | 19 | 19.79 | 8 | 16.33 | 6 | 16.67 |
| Barely | 12 | 12.5 | 26 | 53.06 | 12 | 33.33 |
| Not at all | 5 | 5.21 | 12 | 24.49 | | |
| Total | 96 | 100 | 49 | 100 | 36 | 100 |

Table 8C-2
Influence of Fathers on Choice of Program

| Level of Importance | Science | | Humanities | | Considered | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Extremely | 19 | 19.79 | 2 | 4.08 | 11 | 30.55 |
| Very | 27 | 28.13 | 2 | 4.08 | 9 | 25 |
| Somewhat | 25 | 26.04 | 8 | 16.33 | 15 | 4.67 |
| Barely | 10 | 10.42 | 30 | 61.22 | | |
| Not at all | 15 | 15.62 | 7 | 14.29 | 1 | 2.78 |
| Total | 96 | 100 | 49 | 100 | 36 | 100 |

Table 8C-3
Influence of Teachers on Choice of Program

| Level of Importance | Science | | Humanities | | Considered | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Extremely | 14 | 14.58 | | | 9 | 25 |
| Very | 21 | 21.88 | 6 | 12.25 | 17 | 47.22 |
| Somewhat | 30 | 31.25 | 29 | 59.18 | 6 | 16.67 |
| Barely | 18 | 18.75 | 14 | 28.57 | 4 | 11.11 |
| Not at all | 13 | 13.54 | | | | |
| Total | 96 | 100 | 49 | 100 | 36 | 100 |

TABLE 9A: SCIENCE. THE INFLUENCE OF SOME SCHOOL FACTORS ON CHOICE OF PROGRAM

| LEVEL OF | FRIENDS | | GOOD MARKS IN SCI/MATH | | SCIENCE TEACHERS | | MATH TEACHERS | | INTEREST IN SUBJECT | | COUNSELOR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IMPORTANCE: | N | % | N | % | N | % | N | % | N | % | N | % |
| EXTREMELY | 4 | 4.17 | 40 | 41.67 | 19 | 19.79 | 17 | 17.71 | 18 | 18.75 | 12 | 12.76 |
| VERY | 15 | 15.62 | 47 | 48.96 | 37 | 38.54 | 30 | 31.25 | 32 | 33.33 | 17 | 18.09 |
| SOMEWHAT | 19 | 19.79 | 9 | 9.37 | 23 | 23.96 | 39 | 40.62 | 46 | 47.92 | 19 | 20.21 |
| BARELY | 22 | 22.92 | | | 8 | 8.33 | 7 | 7.29 | | | 15 | 15.96 |
| NOT AT ALL | 36 | 37.50 | | | 9 | 9.38 | 3 | 3.13 | | | 31 | 32.98 |
| TOTAL | 96 | 100 | 96 | 100 | 96 | 100 | 96 | 100 | 96 | 100 | 94 | 100 |

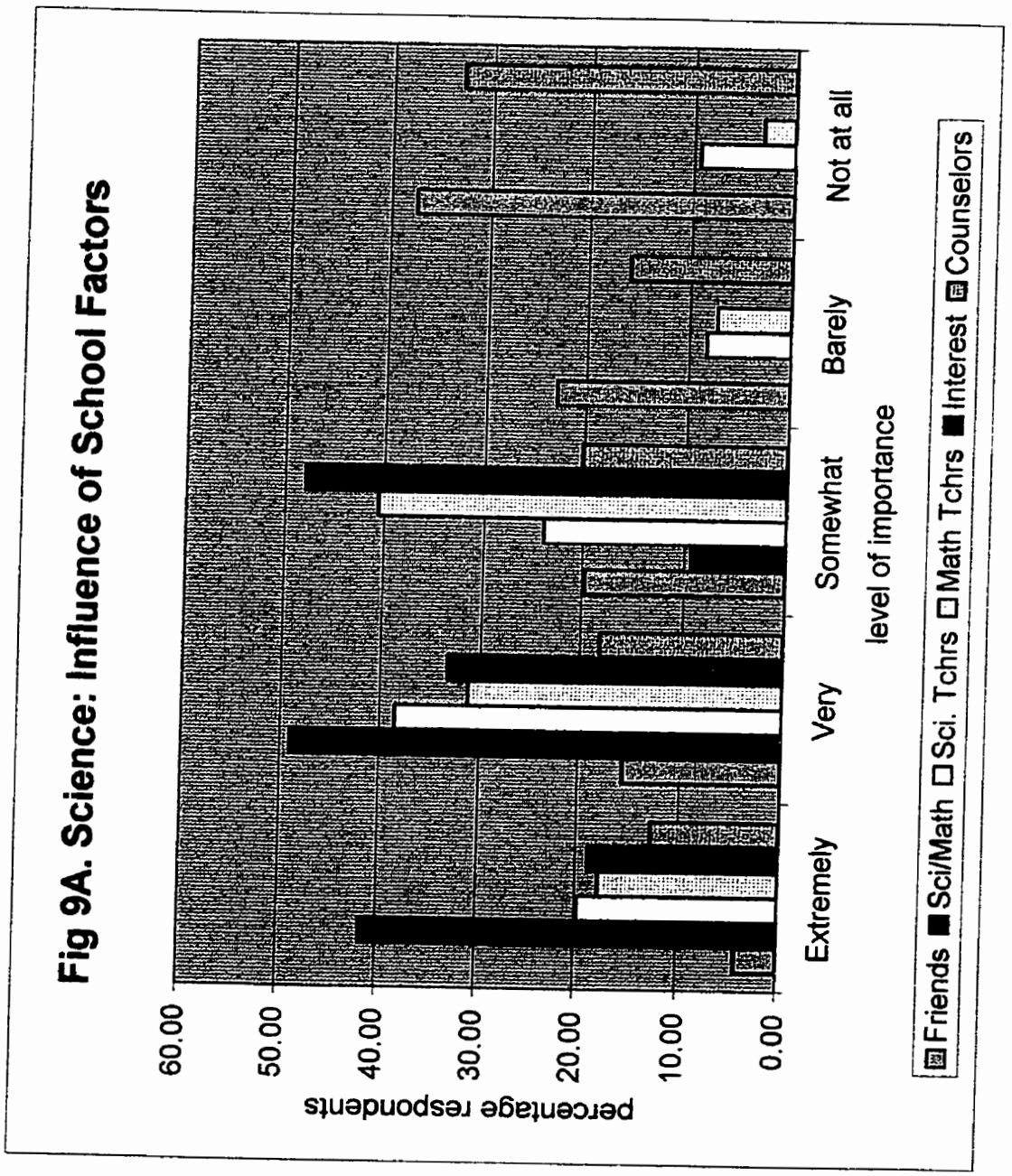
Fig 9A. Science: Influence of School Factors
60.00
50.00
40.00
30.00
20.00
10.00
0.00
percentage respondents
Extremely
Very
Somewhat
Barely
Not at all
level of importance
Friends
Sci/Math
Sci. Tchrs
Math Tchrs
Interest
Counselors

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | N | % | N | % | N | % | N | % | N | % |
| EXTREMELY | | | 7 | 8.24 | 31 | 36.48 | 8 | 9.41 | 20 | 23.53 | 4 | 2.56 |
| VERY | 5 | 5.88 | 15 | 17.65 | 29 | 34.12 | 38 | 44.71 | 12 | 14.12 | 19 | 22.35 |
| SOMEWHAT | 17 | 20.00 | 13 | 15.29 | 4 | 4.71 | 23 | 27.06 | 24 | 28.24 | 10 | 11.76 |
| BARELY | 22 | 25.88 | 8 | 9.41 | 16 | 18.82 | 6 | 7.06 | 13 | 15.29 | 9 | 10.59 |
| NOT AT ALL | 41 | 48.24 | 42 | 49.41 | 5 | 5.88 | 10 | 11.76 | 16 | 18.88 | 43 | 50.59 |
| TOTAL | 85 | 100 | 85 | 100 | 85 | 100 | 85 | 100 | 85 | 100 | 85 | 100 |

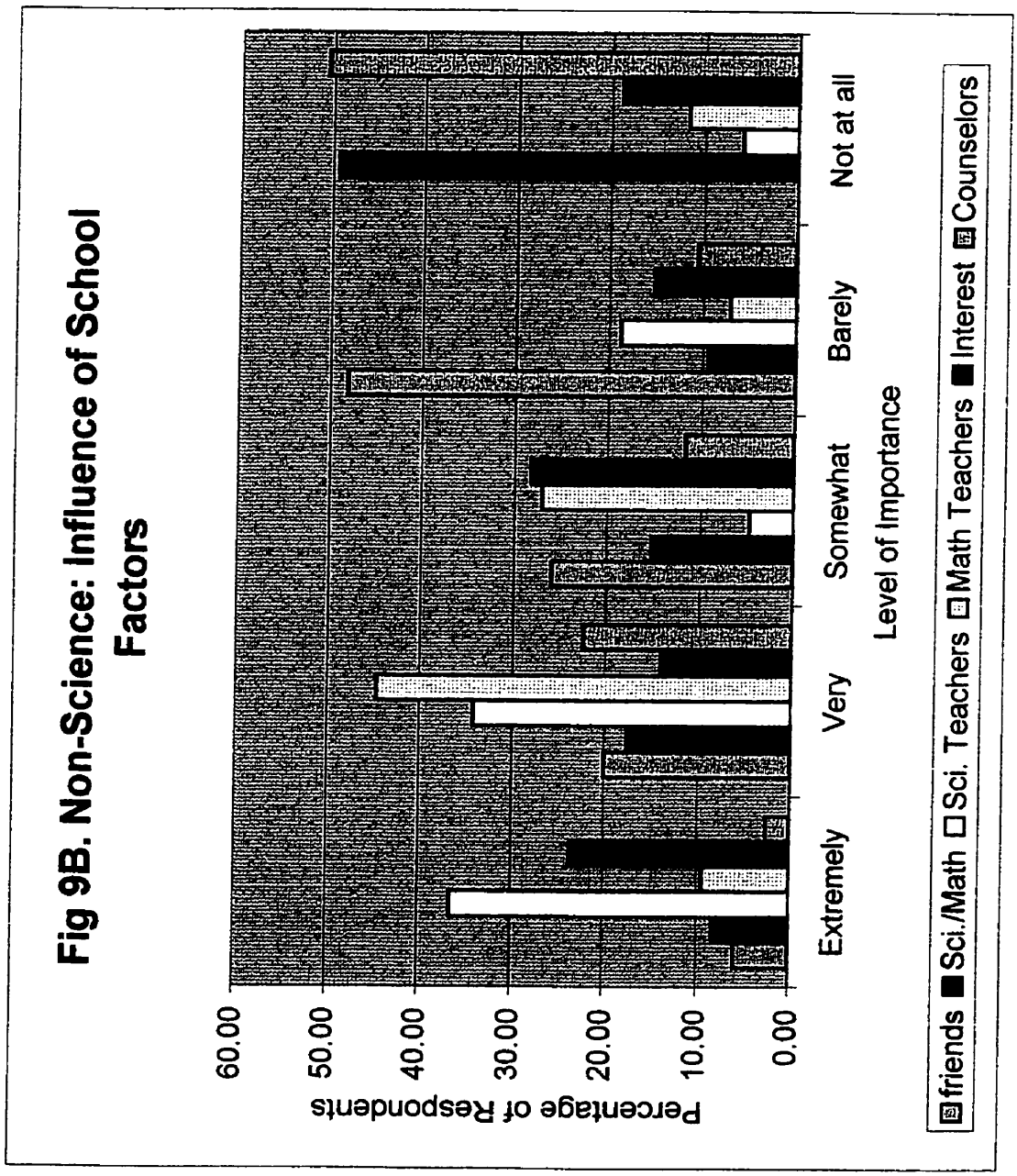
Fig 9B. Non-Science: Influence of School Factors
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Percentage of Respondents
Extremely
Very
Somewhat
Barely
Not at all
Level of Importance
friends
Sci./Math
Sci. Teachers
Math Teachers
Interest
Counselors

**Table10**
**Availability of Counselors and Counseling Services**

| | Single-Sex | | | | Co-Educational | | | |
|---|---|---|---|---|---|---|---|---|
| | Science | | Non-Science | | Science | | Non-Science | |
| | N | % | N | % | N | % | N | % |
| Counselors | 21 | 33.33 | 16 | 39.02 | 12 | 36.36 | 9 | 20.45 |
| No Counselors | 42 | 66.67 | 25 | 60.98 | 21 | 63.64 | 35 | 79.55 |
| Total | 63 | 100 | 41 | 100 | 33 | 100 | 44 | 100 |

**Table 11**
**Distribution of Science Teachers by Gender**

| | Single-Sex | | | | Co-Educatonal | | | |
|---|---|---|---|---|---|---|---|---|
| **Students** | **Science** | | **Non-Science** | | **Science** | | **Non-Science** | |
| **Teachers** | **N** | **%** | **N** | **%** | **N** | **%** | **N** | **%** |
| **Mostly Men** | 36 | 57.14 | 25 | 60.98 | 20 | 60.61 | 28 | 63.64 |
| **Mostly women** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Equally M &W** | 14 | 22.22 | 9 | 21.95 | 6 | 18.18 | 7 | 15.91 |
| **All Men** | 13 | 20.64 | 7 | 17.07 | 7 | 21.21 | 9 | 20.45 |
| **All Women** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 63 | 100 | 41 | 100 | 33 | 100 | 44 | 100 |

Table 12
Perceived Influence of Marriage and Family Role on Choice of Program

| | Science | | | | Non-Science | | | |
|---|---|---|---|---|---|---|---|---|
| Level of | SSS | | Sixth Form | | SSS | | Sixth Form | |
| Importance | N | % | N | % | N | % | N | % |
| Extremely | | | 6 | 13.33 | | | 15 | 25.43 |
| Very | 5 | 9.8 | 8 | 17.78 | 2 | 7.69 | 6 | 10.17 |
| Somewhat | 9 | 17.65 | 17 | 37.78 | 4 | 15.39 | 23 | 38.98 |
| Barely | 21 | 41.18 | 10 | 22.22 | 15 | 57.69 | 9 | 15.25 |
| Not at all | 16 | 31.37 | 4 | 8.89 | 5 | 19.23 | 6 | 10.17 |
| Total | 51 | 100 | 45 | 100 | 26 | 100 | 59 | 100 |

**Table 13**
**Students Receiving Counseling Services**

| Science Students | | | | Non-Science Students | | | |
|---|---|---|---|---|---|---|---|
| Do Well in Science | | | | Do Well in Science | | | |
| Yes | | No | | Yes | | No | |
| N | % | N | % | N | % | N | % |
| 78 | 81.25 | 18 | 18.75 | 34 | 40 | 51 | 60 |