

# 7

---

## Early Scientists Were Men; So Are Today's: Perceptions of Science and Technology Among Secondary School Students in Kenya

**Kenneth O. Nyangena**

### **Introduction**

Science plays a very important role in our lives and is expected to play an increasingly important role in the future of African countries. As such, it deserves to be represented in all its facets by every stakeholder in society. Since the political independence of most African countries in the 1950s and 60s, education has been considered as both a basic human right and investment in human resources for socio-economic development. With regard to gender, policy-makers have emphasised a commitment to equal access. Yet, in order for women to participate in the production of knowledge, it is important to address not only the question of equal access, but also women's success and equal representation at different levels of the system, including higher education.

The 52 percent of the Kenyan population that is female is still under-represented in scientific and technological fields, yet women's role in family responsibilities, e.g., the provision of food, water and health care is strongly underscored by society (Changeiywo 2001). There are many theories that try to explain the continued under-representation of women in science and technology. The images of men as early inventors of science and technology as reflected in science textbooks, teacher's attitudes towards girls who have an interest in science and technology and the social roles assigned to girls and boys by parents are among the factors that, in general, promote the idea that a girl's domain is in the home and that girls have little capacity for science subjects. It is therefore necessary to systematically and empirically establish students' (and especially girls') perceptions of science and technology, in and outside

the school, and how these perceptions are likely to influence their future career choices.

### **Societal Concepts of Gender Values and Practices**

This study was based on the theory of gender as social construct. For centuries, it was believed that the different characteristics women and men exhibited were natural and immutable, determined by biological differences or divinely ordained. These characteristics included both ideas about what was masculine and what was feminine and sets of behaviour considered to be inherently masculine or feminine (e.g., women washing dishes and men working with machines). These perceived characteristics have been shaped and constructed by society. 'Gender' is therefore used to describe socially determined characteristics (e.g., men are rational and women emotional), while 'sex' should be reserved to refer to those characteristics that are biologically determined. It is, therefore, people in a given society who define certain characteristics as masculine or feminine, certain activities as appropriate for men and women and certain norms for relationships between men and women. Prevailing Western conceptions of rationality and objectivity, in spite of their great diversity throughout history, evidently have always been part of the construction of distinctive forms of masculinity. That is, what counts as rationality or objectivity is only what can be given a masculine meaning. Men's preferred styles of reasoning, or standards for maximizing objectivity, have thus come to count as rationality *per se*, leaving women's typical styles and standards marked as infantile.

The conditions of women and men's daily lives and their relative position within their societies are therefore embedded in social, cultural, political and economic frameworks and institutions. However, gender relations and identities are not universal; they vary from culture to culture and sometimes from community to community. For example, it has been reported that villagers in a remote area of Southern Sudan once refused to believe that a Western development worker was a woman because she was driving a Landrover! Understanding gender values and practices is basically central to knowing how societies are organised, how they function and the potential for social (and gender) change.

### **Women's Under-Representation in Science and Technology**

There is a worldwide consensus that women are under-represented in the fields of science and technology and that this under-representation is one of the causes of the continued marginalisation of women in the social, economic and political spheres. Currently, it is the desire of every developing country to attain sustainable development based on self-reliance through the application of science and technology (Ogunniyi 1998). Kenya is no exception and, like other African countries, needs to develop, through science and technology education, a human resources capacity for rapid industrialisation that will ensure economic growth and sustainable development. Strengthening the access of girls to science and technology courses is one way of achieving that development goal.

### This Study

The study reported on in this chapter examined girls' and boys' perceptions of science and technology both within and outside school environments in Kenya in order to:

- find out who students' mentors or role models were in science and technology
- establish students' awareness of cultural or school stereotypes that influence their choice of science subjects
- determine students' knowledge about indigenous science and how this knowledge may influence their perceptions of science generally.

The research was conducted in Nakuru, a district 157 km northwest of Nairobi, the capital city of Kenya. The district has five national schools and a number of provincial and district schools. The study used purposive sampling to identify two high schools, one national and one provincial. These two schools were selected because students in both performed very well in science subjects at national level examinations.

A representative sample of 52 students was randomly selected for interviews. At Bahati Girls School, a total of 28 students in Forms Two and Three were sampled, while 24 students in the same forms were sampled at Nakuru High School. In Form Two, students who do well in sciences are streamlined into science subjects, while, in Form Three, students should have made a decision to do either science or arts subjects.

The study was carried out through structured interviews that were quite elaborate and sought to elicit students' responses to a number of issues in science and technology. The researcher used a tape recorder, with permission from administration and respondents, in order to record as much information as possible. The use of the tape recorder was especially important in capturing quotations that brought out interesting information.

### Boys as 'Tinkerers', Girls as 'Carers'

There is considerable evidence that girls receive less intensive training in science at primary and secondary school levels. Studies in Canada, the United Kingdom and the United States have revealed that girls routinely receive less attention from teachers, who often give answers directly to girls but provide information to boys to enable them to solve problems for themselves (Bowtell 1996). Although girls' science achievement levels frequently equal or exceed those of boys in early primary school, they commonly drop out of science in secondary school, as they come to perceive science as a male-dominated area with very long working hours.

All these studies suggest that, in general, girls have a stronger interest in human and social issues, whereas boys have a stronger interest in 'tinkering', i.e., understanding the mechanical foundations of technology. Since there is agreement that, in developing countries, girls are faced with a variety of factors that conspire to reduce their participation in science and technology, their perceptions and views are very impor-

tant in designing programmes that will ensure more female participation in science and technology.

A study conducted in Australia on students aged between seven and twelve revealed negative and stereotyped perceptions of scientists (Bowtell 1996). Bowtell argues that a standard measure of a scientist could be derived using the Draw-a-Scientist-Test (DAST) as an indicator of children's stereotyping of scientists. The study shows that children are strongly influenced by the images they see around them at home, at school and in popular culture. The argument advanced here is that when they harbor negative stereotypes of scientists and engineers as hardy and 'weird-looking', they could then reject science as a potential career. Another study carried out in the United States showed that fifth-grade students generally perceived scientists as whites who do their work in some kind of laboratory. Fifty-six percent of the students saw themselves at a desk, either reading a science book or taking notes, and the majority viewed the use of science outside school as an extension of their school experiences. Other researchers contend that gender-stereotypical images of science and technology are developed, reinforced and projected through various agents of socialisation in the society. Such images arise from the attitudes adopted by parents, teachers, friends and society in general. The same images are also developed and reinforced through out-of-school influences such as cartoons, fiction, television programmes, news coverage and many other activities.

Traditionally, the image of engineering has been heavy, dirty and masculine and argues that the science field has been seen as an area dominated by men, with an assumption that, for a woman to succeed in engineering, she must be tough, aggressive and less 'feminine'. Most images of science are fundamentally masculine and lack appeal for girls because they seem to contradict girls' emerging sense of femininity. Easley (1983) points out that, if achievement in science is seen as masculine, parents and teachers tend to regard scientific ambition as inappropriate for girls, while girls may also see achievement in science and technology as incompatible with their developing femininity. Since competitiveness and objectivity are seen as attributes of science and technology, the image of science hardly attracts women.

At home, many parents continue to promote sex-stereotyped roles, as by dividing household chores between sons and daughters according to traditional patterns (e.g., boys cleaning shoes and windows, taking out rubbish, washing the car, etc. while girls washed up and mended clothes, laid the table and did shopping). The result of such messages from the home environment is that, when girls reflect on the schools' covert messages on science subjects, the home and school messages coincide, overtly encouraging but covertly discouraging. Girls get the message, withdraw from participation in learning and consequently underachieve in sciences.

### Study Findings

The majority of the students interviewed both at Nakuru High School and Bahati Girls School had done their Kenya Certificate of Primary Education (KCPE) in rural public schools. At Nakuru High School, a total of 19 students out of the 24

interviewed attended rural public schools, while at Bahati, 10 out of the 28 students attended rural public schools. As regards family background, most of the students indicated that their parents are in formal employment. The Principal of Bahati Girls noted that students whose background is poor struggled to pay full fees in any calendar year and required financial assistance from various organisations such as Jomo Kenyatta Foundation to pay their fees. However, students from such backgrounds performed very well and have great ambition about their future. 'I would like to make my mother a proud woman one day', said a female student of Bahati Girls whose mother is a single parent.

Students said they got motivation in their studies from various sources. They know who their role models are and are determined not to let them down. Although a few students had parents who held high professional positions, most students parents' were either primary schoolteachers or worked in middle-level jobs, yet they said their parents were their best sources of inspiration. 'I would like to be a civil aviation engineer because my father is currently an electrical engineer with Kenya Power and Lighting', said a girl at Bahati. Another student at Bahati Girls said that her father, who worked as a salesman with a wine importing and distributing company, reminded her when she was in primary school that while most girls in the community wanted to pursue teaching as a profession, he wanted her to pursue science at university.

Most of the students rated their fathers as their number-one source of inspiration, followed by teachers and mothers. The professions of the fathers in particular seemed to have motivated them to pursue science subjects. Few students indicated that they get motivation from sisters, brothers or guardians. A student at Nakuru High said that her mother, who operated a small-scale business, did not encourage her to do science but that she took the initiative to do science because of a neighbor who was pursuing an engineering degree programme in a public university. There was clear relationship between levels of education of the parents and the motivation of the students; parents in formal employment tend to motivate and inspire their children to do science more than those in informal employment.

Students were also asked about their communities' perception of girls pursuing science and technology. Out of the total 52 students interviewed from both schools, 12 came from pastoral communities, such as the Maasai, and it appeared that such communities still viewed women as source of wealth and, by extension, do not fully support the education of girls. The students from pastoral communities, except those whose parents are in formal employment, said that their communities' perception of women scientists is very discouraging and compared this perception unfavourably to that of agricultural communities who they said are more encouraging. Female students from pastoral communities contended that even their own parents keep on reminding them of the importance of marriage and family. 'My mother keeps bothering me about my marriage', said a student from the Masai community studying at Nakuru High School. These constant reminders of gender role expectation distracted the student from concentrating on her studies so much that she sought

advice from a female teacher. According to this student, every human being, whether man or woman, has what it takes to do any profession. Challenged on whether subjects such as physics or chemistry are not inherently masculine, the student responded that, if a woman wanted to be as muscular as a man, she only needed to go to the gym.

Students were asked to define 'scientist' and 'technologist'. Despite giving rather loose definitions, almost all of the students said they knew more male than female scientists and technologists. The point here was not to question whether this is a true reflection of the representation of males and females in scientific technical work (although census figures suggest that it is), but to suggest that the students' perceptions of their surroundings helps to foster the association of masculinity with science.

Interestingly, all but one of the students viewed technology in terms of technical work. Asked what type of science and technology they practiced during holidays, most said they repaired radios, operated kerosene pumps, fixed electrical appliances, etc. Only one student, from Bahati Girls, mentioned methods of food preservation as forms of technology she practiced during the holidays. The student highlighted how she preserved the remains of cooked food in order to be consumed the following day.

In many cultures in Africa, schooling is still seen as a necessity for males but a luxury for females. Most students who come from pastoral communities in Kenya, such as the Maasai, still believe that a girl's place is in the home. A male student at Nakuru High School from the Maasai community noted that a girl's education is as good as useless, since she will only end up getting married. The student's argument was based on the Maasai cultural view that women are a source of wealth achieved through payment of bride price. Such cultures often deny girls education at even the basic level, and even when girls have access to basic education, they must still overcome immense problems as they strive for equity in access to education, leave alone science and technology.

The students interviewed clearly brought out the different roles girls and boys perform at home. Most girls do household work performed by their mothers, while boys engage in masculine jobs performed by fathers. A male student at Nakuru high remarked, 'I do not cook, but I assist my father to repair his car'. He even said that his father could not allow him to cook by virtue of his sex. The student argued that culture does not allow men to cook and that household chores are a domain of women. However, other students, especially girls, felt that Africans had been policed by their cultures for too long. 'I would like to thank my father, in particular, for insisting that everybody in our home, whether son or daughter, share the cooking', said a female student at Nakuru High School. A female student from Bahati Girls revealed that, besides the household chores and academic work she did during holidays, she also had to double up as an academic, spiritual and social adviser to her siblings. The majority of girls reported that they spend between 25 and 60 percent of their time studying during holidays, while almost all the boys reported spending more than 60 percent of their holiday time doing their studies.

Regarding stereotyping by teachers, a number of students said they were aware of teachers with hidden, negative attitudes towards girls interested in science and technology. The majority of girls, especially in Nakuru High School, said they are taught by teachers who do not use gender-sensitive teaching methods but instead use methods that short-change girls. These teachers show more interest in guiding boys than girls. However, because they were aware of this, the students said they were determined and believed that they will make it. A student from among the girls said, 'I can't be distracted; I am determined to become a neurosurgeon'. This is a clear indication of changing attitudes among female students despite the cultural impediments.

Achievement in science is significantly influenced by teachers, particularly at the elementary level, yet teachers often demonstrate a negative attitude towards science, which is then transmitted to students (Fraser 1992). Many students at Nakuru and Bahati identified inappropriate teaching methods as a major factor influencing girls' negative attitudes toward science and technology. Research indicates that girls' attitudes towards science, along with their achievements and experiences in science, decline considerably during high school. Students at both Nakuru and Bahati were aware of the influence of peer pressure, especially in determining what subjects to pursue.

Many teachers, consciously or unconsciously, use gender stereotypes in their lessons. One researcher, reflecting on the experience of being observed in the GIST project, wrote that, if no obvious interest in the subject or topic is displayed, the male teaching staff often flatter the girls or are mildly flirtatious towards them, finding that this is often a successful way of encouraging them. In the same circumstances, male teachers will probably appeal to the boys' competitive instincts. We accept that treating the sexes differently in this way may well be encouraging them to see their roles in the world of science differently but are reluctant to abandon successful teaching techniques.

Another way in which teachers' preconceptions may influence their relationship with girls and boys is in their perception of who is competent and who needs help. Science teachers (like teachers of other subjects) generally interact more with boys than with girls in class. Girls at both Nakuru and Bahati said they fear consulting male science teachers (especially unmarried ones) because of the gossip that then goes around. Unpleasant stories of dating your teacher discourage girls from consulting male teachers.

While interviewing a female student at Bahati Girls, the student said she hated mathematics as a subject yet did well in other science subjects. She revealed that her mother is a single parent and that her father had abandoned the family. While I could not figure out the relationship between the poor performance in mathematics and the single parenthood, the student said that her mathematics teacher resembled and behaved in every manner like her brutal and unkind father. The principal of Bahati Girls was aware of this case and had tried to advise the student in vain. The

student said she did not care about failing mathematics because of a teacher who exhibits her father's characteristics.

The study results revealed that most female teachers in both Bahati and Nakuru taught either biology or chemistry, while most if not all male teachers handled physics, mathematics and computer science. Asked whether students viewed male teachers as better role models than female teachers, most students (including 64.3 percent of Bahati Girls students) strongly disagreed, saying that both male and female teachers are human beings with different potentials. However, while 40 out of 52 students interviewed either disagreed or strongly disagreed with the statement that male teachers are better role models, a female student at Nakuru High claimed that male teachers take more time and are more patient when advising students on subjects and career choices than female teachers. She said male teachers are better in identifying the talents of students, and that they also advise and encourage students more than female teachers who, she said, they make careless and personal remarks when students make small mistakes.

### Conclusions

I have discussed so far, to a greater or lesser extent, the masculine image of science as abstract, analytic, 'objective' and controlling, developed so that 'natural philosophers could demonstrate their virility by the scientific and technological appropriation of a mechanical earth' (Easley 1983). At first sight, the suggestion that science is inherently masculine appears radically different from the suggestion that science is simply packaged in a masculine way. But on closer inspection, these views may converge. If school science were made more girl-friendly, centred on girls' interests and ways of working, would this not be one step to creating a feminine science? And if considerable numbers of girls (and boys) emerge from school having learned science in this way, will science as an institution not begin to change?

There is no doubt that developing countries have put a number of mechanisms in place towards addressing the current under-representation of women in science and technology. However, several issues are still being raised as possible explanations for girls' continued under-representation. This study established students' awareness of the negative attitudes some members of society have towards women with an interest in science and technology. The students are also aware of the challenges facing them in achieving their goals as scientists. The students felt that, unless men, who are the majority in decision-making positions, accept the fact that women are equal partners in development and that their position goes beyond the social role of home-maker, the status quo will remain. The study results indicate that student's perceptions definitely shape their attitudes towards science and that positive perceptions will therefore bring positive attitudes towards science and technology.

It is on this basis that there is need to develop policy guidelines to eliminate the gender bias that is rampant in science and technology education. There is also need to provide infrastructure and funding to develop networks of female scientists, educators and even students. Provision of adequate pedagogy, curriculum, facilities,

equipment and supplies for teaching girls is the first step towards increasing their participation in science and technology.

### References

- Bowtell, E., 1996, 'Australian Children of Scientists', in *Primary and Junior Science Journal*, Vol. 12, no. 1.
- Changeiywo, J. M., 2001, 'Gender Perspectives in Science and Technology in Kenya', in *Journal of Education and Human Resources*, Vol. 1, no. 1.
- Easlea, B., 1983, *Fathering the Unthinkable: Masculinity, Scientists, and the Nuclear Arms Race*, London: Pluto Press.
- Fraser, P., 1992. 'How Can Teacher Education Change the Downhill Trend of Science Education?', in *Journal of Science Teacher Education*, Vol. 3, no. 1, pp. 21-26.
- Mwangi, J. G., 2001, 'Using Pre-schools to Reduce Gender Imbalance among Science Professionals in sub-Saharan Africa: Critical Issues', in *Journal of Education and Human Resources*, Vol.1, no. 1.
- Ogunniyi, M. B., 1998, 'Effects of Science and Technology on Traditional Beliefs and Cultures' in M. B. Ogunniyi, ed., *Promoting Public Understanding of Science and Technology in Southern Africa*, Cape Town: Wynland.