

Why NOT Engineering? The Process of Career Choice amongst South African Female Students*

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This paper seeks to inform current initiatives to attract more women to study engineering. The pool of suitably qualified students at UCT was investigated, and from this group an interviewee sample was drawn of top achievers in school mathematics and physical science who had elected to study courses other than engineering. The interviews yielded information on the process of career choice amongst these students. Findings concerned the universality of medicine as an initial choice, and the current attraction towards commerce. Engineering was only considered by students who ultimately chose B.Sc. degrees, and these were the only students who had a positive experience of school physical science.

INTRODUCTION

IN THIS PAPER we report on an investigation into how young South African women, who are high achievers in school mathematics and physical science, decide what to study at university. In particular the study aims to find out how, if at all, engineering is considered within the process. In a previous study by Jawitz and Case [1] the reasons given by first-year engineering students for studying engineering were analysed in order to better understand what attracts school-leavers, particularly young women, into the career. In the course of that study it became clear that it was also necessary to investigate the career choice process of female high achievers in school Mathematics and Physical Science who had not chosen engineering even though they had the prerequisite marks for access to engineering programmes.

POOL OF SUITABLY QUALIFIED FEMALE STUDENTS

Projects to encourage more women to consider engineering as a career usually assume that there is a large pool of suitably qualified female matriculants available to make such a career choice. The first stage in this study set out to investigate the size and nature of this 'pool'. A careers profile was constructed of South African female first-year students at the University of Cape Town (UCT) straight from school, with a C symbol or higher for Higher Grade (HG) Mathematics and Physical Science, i.e. marks sufficient for entry into any

engineering programme at UCT. The 438 students from the 1999 intake who fell into this category were analysed according to race and course of study (Table 1). Half were registered for one of two programmes i.e. medicine (30%) and business science (20%). Only 11% were registered for engineering. The proportion of African students in this group was found to be small (12%).

The figures in Table 1 reveal stark differences in the career choice of women in this group. Amongst white women business science was the most popular degree by a large margin (33%) while the proportion of coloured and Indian students female students registered for medicine (36%) was slightly higher than that registered for business science (33%). Amongst African students the largest proportion was registered for engineering (35%) with medicine a close second (30%). This difference in registration patterns suggests that there is a strong relationship between social background and career choices amongst young South African women.

RELATED STUDIES

Studies in the science and engineering education literature on factors influencing the choice of careers were reviewed in Jawitz and Case [1], with the career model developed by Dick and Rallis [2] found to be most useful. This model states that students make their career choice on the basis of the relative values of the careers and their beliefs about themselves. The relative value of a career relates to both intrinsic factors such as intellectual interest as well as extrinsic factors such as expected salary and the length of study. According to the model, student beliefs about themselves

* Accepted 22 May 2000.

Table 1. SA female first-year high achievers in mathematics and physical science

Programme of study	Length of degree	Total	White	Coloured/Indian	African
Business Science (B.Bus.Sc.)	4-year	133 (30%)	95 (33%)	32 (33%)	6 (11%)
Medicine (MBCHB)	7+1 year	88 (20%)	37 (13%)	35 (36%)	16 (30%)
Science (B.Sc.)	3-year	66 (15%)	54 (19%)	6	6 (11%)
Engineering (B.Sc.(Eng.))	4-year	47 (11%)	14 (5%)	14 (14%)	19 (35%)
B.Sc. (OT/Physio/Log)	4-year	43 (10%)	37 (13%)	5	1
Arts (BA)	3-year	32 (7%)	32 (11%)	0	0
B.Com.	3-year	20 (5%)	10	5	5 (10%)
Social Science (B.Soc.Sc.)	3-year	19 (4%)	18 (6%)	1	1
Total:		438	287	98	54
		100%	66%	22%	12%

are formed from their interpretation of past experiences and perception of the attitudes and expectations of others, such as teachers and parents (referred to as socializers). Dick and Rallis posit a dynamic relationship between the student and socializers in which interactions shape their experiences and aptitudes. All of this takes place within the context of a particular set of societal stereotypes and realities, such as the sexual division at the workplace.

In reporting on the reasons South African students give for study engineering, Jawitz and Case [1] found that male and female students and black and white students enter the profession for very different reasons. For example, while white female students appear to be primarily influenced by their school mathematics and science teaching, and a family supportive of this career choice, the majority of black female students were motivated by the opening up of opportunities to serve their community and to prove themselves in a career dominated by white males. The study identified a category of factors related to the socio-political environment (Social Identity) not reflected in previous studies of this kind.

For the current study it was decided to investigate the broader literature in the area of career decision-making. Gati [3] presents a career decision-making model based on the sequential elimination of alternatives. According to this model a student makes a career choice starting with a set of alternatives. She or he selects aspects according to relative importance. Aspects that come into play are personal attributes (do I enjoy working with people) occupational aspects (nature of the job), resources she or he has (money, time) and more information gathered around the field. The student then ranks the aspect by order of importance and eliminates occupations that fall outside the accep-

table range, eventually leaving the most desirable option. Gati's model has been critiqued by Carson and Mowesian [4] who argue that it presents a deterministic view of career decision making that is focused too strongly on the outcome (i.e. the decision), and ignores the complex and dynamic nature of the decision-making process.

METHOD

We conducted in-depth interviews with a diverse group of young women to explore the full range of factors that formed part of the career decision-making process, and to explore the position of engineering as a potential career option within this process.

The interviewee sample was drawn from the pool in Table 1, and excluded students studying engineering. Only South African female students straight from school were included to minimize other influencing factors. Initial sampling was done on a random basis and was adjusted to allow for maximum diversity in terms of course of study and race. The final sample is given in Table 2. Participants were contacted by phone and invited to participate. All students who were approached agreed to be interviewed.

Data was collected using semi-structured interviews conducted individually by the authors. Three pilot interviews were conducted to test the protocol of questions. The interviews lasted approximately thirty minutes and were audio-taped. Interviews were conducted in one of the author's offices except in two cases, where they were held at the participant's place of residence. Each interview was transcribed by two of the authors in order to ensure that information was captured as accurately as possible.

Table 2. Interview sample

Area of study	White students	Coloured/Indian students	African students	Total
Medicine	1	2	1	4
Business Science	1	2	1	4
Science (Geology)	1		1	2
Humanities	2			2
Totals	5	4	3	12

Interview protocol

An interview protocol helps to focus the researcher while at the same time allowing flexibility during interviews. Drawing from our experiences and the results of our previous study [1] we identified areas that needed to be explored to achieve our present aims. We then developed questions to guide our interviews. The final interview protocol had the following sections:

- Section A was an introduction to explain the study and make the participant feel at ease.
- Section B focused on the participant's schooling. It explored the influence of the school culture, experience and environment (such as teachers and subjects) on the career choice and whether the participant found herself being pushed in a particular career direction.
- Section C focused on the role family members and friends played in the process of making a career choice.
- Section D exploring the actual process followed by the individual in reaching a final decision.
- Section E focused specifically on exploring whether engineering was considered in the process of career choice and if so, how.

Analysis

After reading through the interviews the authors met to identify aspects of the career choice process and pertinent background information emerging from the data. A range of elements was noted including what attracted them to the career, when the decision was made, the relative influences of teachers, parents and friends, the type of school, description of guidance counselling activities, etc. The interviews were then grouped according to the interviewees' fields of study. Each author was assigned a group and did a preliminary analysis of the interviews using the aspects identified earlier. These were presented and the list of aspects/categories was refined. Each group was then analysed by a different author to add any additional information that had been missed. These analyses allowed for cross-comparisons across the whole group, and also between and within discipline areas.

PRELIMINARY FINDINGS

Medicine – the universal first choice?

In contrast with Gati's [3] model of students starting with a wide range of options and then eliminating them, the range of careers the interviewees reported considering was extremely limited. In fact our data suggests an almost universal first career choice of medicine and then a process of moving away from (or remaining with) that choice.

In all except two cases, the interviewees had initially seriously considered a career in the health sciences, in most cases medicine. There are

at least two possible reasons for this. Firstly, given the stringent entrance requirements for admission to medical faculties only the top high school students would be eligible to consider it at all and this was the group we drew our interview sample from. Secondly, in recent decades there has been an opening up of the medical profession to women, to the point where currently 65% of the intake into the MBChB programme are female, compared to an overall 57% female enrolment at UCT. Beyond this there seem to be social reasons why medicine is so strongly and universally considered by top female students as a first choice.

Interviewees reported on a range of factors that were involved in moving them away from their first choice of medicine. These included:

- family members who were themselves doctors, and hence exposure to the long hours of work and conditions of service;
- the implementation of the national scheme whereby doctors are required to serve a year in community service before starting their internship; and
- having to work with blood and the increased exposure to HIV/Aids.

The role of teachers seems to be varied in this respect. Some teachers clearly promoted medicine as the preferred career but in other cases teachers tried to persuade pupils in the direction of careers other than medicine.

The four interviewees who finally chose medicine all have at least one parent working within the health sector, as radiographer, medical technologist, physiotherapist and hospital clerk, but notably none of these have parents who are themselves doctors. By contrast, the students in our sample who had a parent who was a doctor did not choose medicine, often after considerable parental dissuasion. For two of the interviewees who chose medicine evidence was presented of high school teachers having tried to dissuade them from medicine as a career choice.

Only one student reported considering 'lots' of careers and described a very active career search process involving work-shadowing, career talks, and visits arranged by the teachers at a private all-girls school. Despite following this active process, which included eliminating medicine because she didn't like 'seeing people in pain and blood all over' and finally deciding to do something in the environmental area, she only made the decision to register for Geology a few days before registration.

Confidence around career choice

In all except one case, interviewees showed a high level of confidence in their choice of career, even though in the case of medicine and Business Science their experience of the first year programme had not matched their expectations. This confidence appears to be the result of having

kept and defended their choice for a long time, in some cases from early childhood, the latter situation especially evident amongst the medical students. Students also expressed certainty in cases where strategic decisions had been made to undertake a career with sound job prospects and scope for development (e.g. business science), or where decisions were based on opportunities that arose, i.e. upon being awarded a bursary (e.g. B.Sc. geology) or being accepted into the faculty (e.g. medicine).

The role of parents

All students made reference to their parents' views, indicating that this was an important aspect of their career choice. In most instances parents had a specific viewpoint on what they should do (in only four cases did the parents not suggest a specific career). Frequently the mother and father did not have the same approach to their daughter's career choice-making with one parent being dictatorial while the other was more supportive and open-minded. Commonly there was considerable conflict between a parent and a student which was only resolved when one side capitulated. In all of these situations bar one it was the parents who capitulated, and it is interesting to note that the one student who bowed to her parent's choice is the only student in the sample earlier described as being uncertain with her choice.

The two main issues over which parents and daughters disagreed concerned appropriate careers for women and ultimate job security. Parents showed concern for their daughter's safety if having to go to remote areas in the fields of journalism or medicine while humanities degrees were not seen as providing viable job opportunities. The key role played by parents highlights the role of socializers in career decision making as described by Dick and Rallis [2].

The school environment and the role of teachers

We were interested that interviewees were able to describe the culture and identity of their school in quite specific terms. The following 'types' of school were mentioned:

- academically oriented;
- business oriented;
- strong science school;
- poor maths and science school.

The nature of the school environment constitutes a key element of the social and cultural milieu identified as an important factor by Dick and Rallis [2].

Both interviewees registered for science degrees described their schools as 'strong science schools' with well-organised career guidance support. One of these students reported that at her school most of her classmates were choosing engineering, and she chose science to be different. These two students were also different to the rest of the sample in displaying a positive attitude to science.

The majority of other students showed a strong dislike to science based on their experience of the subject at school.

In general, school guidance activities did not appear to play a big role in students' career choices. In most cases career guidance did not extend to an individual level and seemed to be limited to guest speakers. Work-shadowing activities, where they occurred (in two cases), appeared to have had an important influence on students' career choices. Students referred to aptitude tests as confirming what they already knew, or else disregarded their suggested choices if they didn't confirm their prior choice.

The only cases where the teachers' opinion was very influential was where there was a close relationship with an individual teacher of a subject that they liked or that they did well in. Students often reported a perception that the majority of teachers were pushing either individual students or the whole class in a particular direction. In one instance there was a lone mathematics teacher suggesting that female students should consider studying engineering, but this was reportedly ignored as students had already made up their minds:

There was my maths teacher . . . he couldn't understand why I ever wanted to do the business science degree. He thought that we should be doing something like engineering. He says, ja, women never had those kind of jobs before, and now they have the opportunities . . . they rather want to go and do a business science degree and make money . . . He was talking to the whole class, and . . . there's this one girl who actually went and did engineering . . . but you know people, they were set in their career decisions already and they didn't take much notice of him. (Tahira, Business Science)

Attitude to engineering

Two students reported having considered engineering, one of whom mentioned this spontaneously in the interview. They decided to eliminate engineering for the following reasons:

- Limited in scope: 'I think that once you've got an engineering degree, except for if you've got chemical engineering, you're pretty much focused in one direction. Whereas if I've got a broad-based scientific degree I can take that where I want.' (Mary, Geology)
- Wanted to be different: 'Most of my classmates are doing Engineering and I wanted to be different.' (Felicia, Geology)

Towards the end of the remaining interviews we asked the question 'Did you ever consider engineering?' The following list describes the range of reasons students gave for not even considering engineering as a possible career option. Each is illustrated with a representative quote:

- Never gave it a thought – doesn't interest me at all: 'My father (is an engineer and) the stuff he

brings home from work doesn't interest me at all. I have never even thought about engineering. Not even like this much of a thought,' (demonstrating by holding thumb to first finger). (Camilla, MBChB)

- Too much mathematics: 'Most of your subjects are Maths and I found that was a total turn off. And I spoke to people about business science and they said to me 'you only have to do Maths in your first year' which was a bit of a plus.' (Tracey, Bus Sci, poor school mathematics teaching due to teacher disruptions)
- Dislike of science: 'I honestly hated science. I do well in science. I'm logical and I have got the talents in that area but when I just think of science I just wanna run.' (Camilla, MBChB, A for Physical Science HG)
- Want to work with people: 'I'm a people's person, I want to work with people, not things. I just imagine them (engineers) to sit with these big drawing boards and . . . you know, all isolated by themselves.' (Nikki, Psychology)
- It's a male-dominated career: 'Everybody was saying that it's too male-dominated It's not a career for females' (Kathy, MBChB)

DISCUSSION

The only students who had engaged with engineering as a potential career choice were the two who chose to study science degrees. They had attended what they called 'strong science schools' and had a positive attitude to science. Their decisions away from engineering were based on quite careful and strategic choices. It seems that the experience of science in schools is a significant factor influencing the choice of engineering and prospective candidates to study Engineering are likely to be found amongst those young women considering registering for a Science degree.

We noted the phenomenon of these top female mathematics and science students being pointed towards medicine by a range of socializers. It is interesting to consider that it is only very recently that this profession has become 'gender neutral', and it might be useful to uncover how and why this happened, to see if there are any lessons for the engineering profession. Webster and Burrows [5] have made a preliminary analysis in this regard, and suggest that women's experience as consumers of medicine has influenced the ease with which they have recently entered the profession.

Commerce, and business science in particular, is a popular career choice mainly due to perceived job opportunities. These perceptions appear to be reinforced by parents, teachers, and the general

cultural milieu. This is also backed up by strong marketing campaigns, especially from private business colleges. A large proportion of interviewees mentioned having guest speakers at school talking about careers in the business world, much more so than any other single career area.

In comparison with our earlier study of engineering students there was a remarkable lack of discussion about the broader social identity factors that we previously identified. These factors had been strongly related to black female engineering students, whereas in the present study no students of any race mentioned such notions. This might be related to the small sample size, with only three African students interviewed.

CONCLUSION

Medicine holds a strong initial attraction amongst female high achievers in mathematics and science in South Africa. The shift away from this choice is a significant element of the career decision-making process amongst this group. Enrolments at UCT in 1999 suggest that the shift away from medicine and towards business science is the dominant force amongst young white female school students.

It is a significant finding of this study that the only students who even considered engineering were those who ultimately chose to do B.Sc. degrees. These two were also the only ones in the sample who enjoyed their experience of physical science. The rest of the sample, despite having performed well in physical science at school, were either indifferent or had a strong dislike for the subject. This leads us to suggest that a key to encouraging more young women to consider engineering is find ways to improve their enjoyment of physical science at school.

In contrast to the high profile marketing and image of careers in business, engineering as a career seems almost invisible in the public eye. This seems to particularly affect the career choices of young white women, who currently form a large proportion of the available pool described in Table 1. We would suggest that initiatives to promote engineering need to consider adopting more focused and professional marketing strategies, similar to those used by the colleagues in commerce. These initiatives need to convey the message that engineering does involve working with people, and that as a career it offers good job opportunities and promotion prospects. These initiatives need to reach students before Grade 11, when career choices are often finalised.

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