

ICT Perceptions of Female Non-ICT First Year Students in South Africa

Charles van der Vyver
charles.vandervyver@nwu.ac.za

Malie Zeeman

North-West University
South Africa

Abstract

This research aims to identify the perceptions amongst young female adults that influence them not to enrol for an ICT-related qualification. A sample of 509 first year female students who are not enrolled for an ICT-related qualification were selected out of a population of roughly 3000 students. The research was conducted at the Vaal Triangle Campus of the North-West University in South Africa. Questionnaires were distributed to the students, and focused on demographic data, previous computer experience, and ICT-related awareness and perceptions. It was found that poor mathematics results and the perceptions of both teachers and parents were the major contributors to the choice not to enrol for ICT-related qualifications. It was concluded that greater effort should go into improving mathematics results from primary school level, and that the negative stereotypes regarding the ICT industry should be addressed. Future research should focus on developing interventions to address the aforementioned findings, and to document the successes after these interventions have been implemented.

Keywords

Female, ICT, Perceptions.

1 Introduction and Problem Statement

The continuous decline in the number of students who enrol for ICT related courses at universities has been reported by countries all over the world. Even though ICT is part of everyday life and many career opportunities are available, students are not inclined to follow a career in ICT. This phenomenon has been a topic of discussion and research for the past decade (Lomerson & Pollacia, 2006; Varma & Hahn, 2008; Clayton *et al.*, 2010; Nelson & Veltri, 2011). In South Africa ICT has been identified by the Department of Education as one of the scarce skills in 1997 when the “Education

White Paper 3: A Programme for the Transformation of Higher Education” was released. The shortage of technology and ICT skills was recognised in this paper and one of the objectives of the Department of Education was to focus on these fields of study in the reformed education system in South Africa. Unfortunately the situation has not improved since then. In fact, there is evidence that the shortage in IT skills has become even worse (Kirlidog & Zeeman, 2011).

The backlog in supply of ICT skilled people in many countries could be due to the fact that the perceptions of ICT as a career are not appealing to young people – specifically women. In fact, the underrepresentation of women in the ICT industry has been a topic of extensive research the past few years (Pretorius & deVilliers, 2009; Nelson & Veltri, 2011). Although research shows that a gender diverse workforce can lead to increased performance and competitiveness, the number of women entering the ICT workforce is declining in some countries (McKinsey, 2010; Nelson & Veltri, 2011). Even though ICT is part of our everyday lives women are not inclined to study ICT nor follow it as a career. In fact, the gender gap in the ICT industry is widening to such an extent some countries that it has been identified as one of the male dominant workforces in the world.

The objective of this study is to determine some of the factors that influence the perceptions of first year female students on ICT careers and ICT-related qualifications.

We firstly discuss the shortage of ICT skilled people globally and in South Africa in particular. A discussion on the perceptions of women regarding ICT careers and their role in this industry follows. The research method that was followed is explained followed by a discussion on the findings. The factors that influence perceptions on ICT related careers are discussed, as well as factors that influence the participants to not enrol for ICT related qualifications. We conclude with some recommendations and remarks on areas for future research.

The result of the study can be used by the Department of Education in order to improve the perceptions of learners regarding ICT related careers.

2 The ICT Skills Shortage

During the past decade ICT has emerged as a vital part of the global economy. Almost every industry is in some way or another dependent on technology for their day to day business activities. It is becoming critical for business managers to have skilled and highly qualified ICT people on their team who understand new technology and can be innovative in using technology to the benefit of the business. In 2008 the U.S. Department of Labor estimated that computing professions will be one of the fastest growing sections of the labour market in the next decade (Denner *et al.*, 2009). Even though computing professions are growing due to the dominant role ICT plays in the world today, there is concern about the declining workforces and skilled ICT people to fill these positions. In the year 2007, the European Commissioner for Information Society and Media estimated that there will be a shortage of about 300 000 ICT skilled people in EU by the year 2010 (Varma & Hahn, 2008). There is growing evidence that the predicted ICT skills shortage is becoming a reality and a matter of serious concern (Gallivan *et al.*, 2006; Lotriet *et al.*, 2010; Zarrett & Malanchuk, 2005). According to Gallivan *et al.* (2006) a major contributing factor is

the under representation of women and other minority groups. Worldwide efforts have been made in an attempt to address the ICT skills shortage (Lotriet *et al.*, 2010).

In South Africa the Department of Education attempted to address the problem with the Birchwood Declaration of 2007 (Lotriet, et al., 2010). The declaration recognizes the economic importance of ICT's within South Africa and the fact that the skills gap impacts negatively on the global competitiveness of the country. The declaration recognizes the part tertiary education plays in addressing the shortage and the fact that there are barriers to entry for ICT education that result from a range of factors.

3 Women in ICT

The declining number of women in ICT related careers in countries such as the USA and Australia in the last two decades is a matter of concern to everybody involved in ICT (Pretorius & deVilliers, 2009; Nelson & Veltri, 2011). The magnitude of the problem is clear from the fact that, for example 40% of the Technology workforce in the USA in the year 1986 was represented by women and in the year 1999 this figure decreased to an alarming 29% (Ramsey & McCorduck, 2005). Cultural influences have a major impact on the perceptions about ICT which influences the number of women entering the ICT field (Clayton et al., 2010).

According to Gallivan *et al.* (2006), the problem of not attracting women to ICT should have been resolved, when in fact it has actually worsened. Freeman and Aspray (1999) are of the opinion that the shortage of ICT skilled people can be resolved by encouraging women to enter the ICT jobs market. Freeman argues that there should not be a shortage of ICT skills if women could be equally represented in relation to their male counterparts.

Career choices are more complex for women than for men because of the many factors women take into consideration (Nelson & Veltri, 2011). Some of these factors are family life and responsibilities, cultural stereotypes and the perceptions women have of ICT careers which can be a deciding factor. The perception of ICT is formed based on past experiences and exposure to ICT at home and at school. Role models such as teachers and parents can have an influence on perceptions of technology and computing a career.

Nelson & Veltri (2011) developed a framework (figure 1) showing the complex environment within which women have to make career choices.

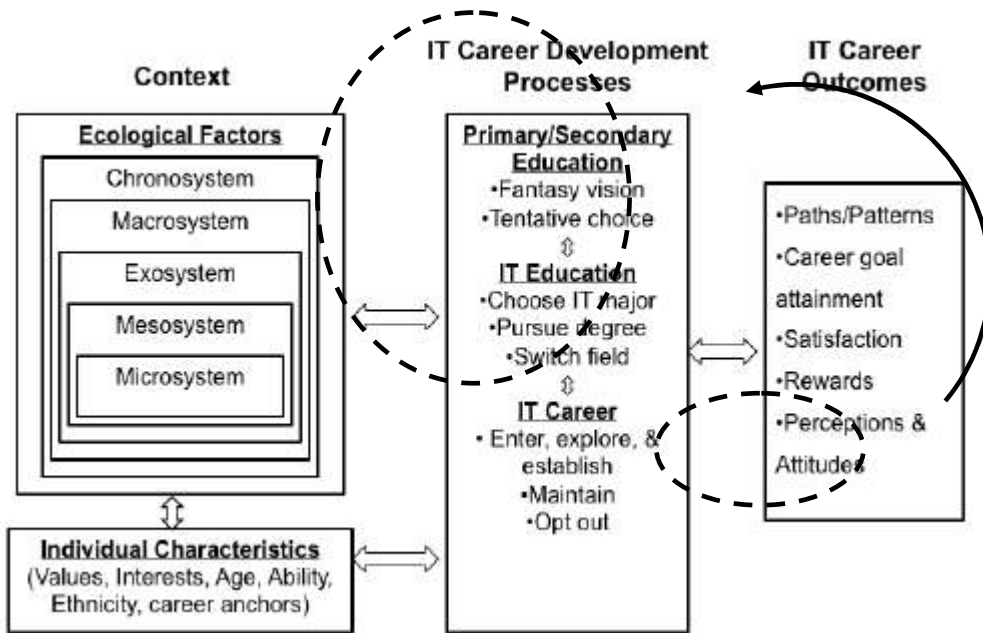


Figure 1. A Person-Process-Context-Time Approach to Understanding Women in IT adapted from Nelson & Veltri, 2011

The context within which a career choice is made consist of ecological factors associated with five major subsystems that influence human behavior. Each subsystem represents the level of interaction which has an influence on behavior, e.g. the *micro system* represents personal interactions with people such as the home, school, peers, or the work setting, etc. The *macro system* represents the cultural environment within which an individual lives.

The circled areas in Figure 1 above show the areas of interest for this study. It shows the career development processes and the relationship between perceptions and education at primary and secondary level and eventually career choices. Primary and secondary education is listed as significant role players during the career development process of young people and women in particular. Perceptions and attitudes are formed and moulded by role models during the career development process.

Attracting women to ICT involves analysing the factors that influence their perceptions of ICT more closely. The declining number of female students enrolling for ICT related degrees at university is an indication that they are influenced negatively towards technology at some stage of their lives before the have to make a career choice (Varma & Hahn, 2008; Von Hellens, 2011). Meredyth reports that the interest and confidence of girls in the use of computers declines to a great extend during their junior to senior high school years (Meredyth, 1999). Girls develop negative attitudes at school and loose their confidence towards technology due the fact that boys are associated more with technology and seem to be more comfortable and at ease with technology (Pretorius & deVilliers, 2009; Clayton et al., 2010). Girls often have to stand their ground against muscular attitudes of boys at school and later on, men in the workplace to persist their interests in ICT (Nelson & Veltri, 2011; Margolis & Fisher, 2002).

Clayton et al. (2010) investigated gender stereotypes, ICT stereotyping, media stereotyping and stereotyping of ICT in education. The overwhelming message is that computing is perceived to be a male dominant field of study and career. Because of their caring nature females are seen as caretakers within some societies and cultures, and are therefore not seen as worthy of occupying a valued and highly respected occupation (Varma & Hahn, 2008; Clayton et al., 2010). The gender stereotype role of women is often enforced by the perceptions of society in general though the media. Unfortunately family members, teachers, parents and peers often confirms these perceptions as well as discouraged girls from persisting when confronted with challenges (Margolis & Fisher, 2002).

Girl's perceptions of ICT are negatively influenced by the technical environment and also the mathematical skills associated with computing (Clayton et al., 2010). The reality is that ICT entailed much more than only the technical aspects of the field. There is a wide range of less technical aspect of ICT that females could get involved in (Pretorius & deVilliers, 2009). Improved knowledge about the range of professions in ICT could have a positive influence on female interest in this field of study and careers to pursue.

The choice of career is often determined by school achievements, specifically in mathematics and sciences. At many higher education institutions a minimum mathematics achievement is required as a prerequisite for entering for an ICT qualification. In his study, Steele (1997) established that females did not perform as well as males in mathematic. ICT is often labeled as a difficult and technical field of study (Bissell et al., 2003; Varma & Hahn, 2008). A study done at a College in Norway revealed that students are of the opinion that computing is too difficult for females to study (Varma & Hahn, 2008).

The image that female students associate with a career in ICT is not always encouraging. A study in the USA revealed that female students think of a computer person as an antisocial male person (Varma & Hahn, 2008). The 'geek' or 'nerdy' image of computing is not appealing to the majority of female students (Margolis and Fisher, 2002; Varma, 2007). Computing professions are often seen as socially boring because of long working hours and social isolation (Clayton *et al.*, 2009). Social isolation is one of the factors that seem to have a significant negative influence on the female's perception of ICT careers. However, Margolis and Fisher (2002) state that the ICT students in their study did not fit the description of a computer freak or boring antisocial person.

The negative perceptions of ICT amongst women outweigh other benefits such as competitive salaries, job security and flexible working hours (McKinney, Wilson, Brooks, O'Leary-Kelly, and Hardgrave, 2008).

It is interesting to note that in some countries such as Greece, Turkey, Spain and the South American countries, amongst others, women are well represented in computing careers (Clayton et al., 2010). South Africa is unfortunately not one of

those countries. Based on figures from the HEMIS⁹ database, i.e. a database showing the annual figures of enrollments and number of students who complete their qualifications at higher education institutions in South Africa, the skilled number of women who complete their studies in ICT is under representative and declining steadily.

The ICT industry could benefit in several ways by encouraging women to enter the ICT field. In South Africa and countries all over the world the shortage of ICT skilled people could be addressed by including women in the industry and embracing the contribution they could make towards all the aspects of the field, specifically towards the social and humanitarian aspects.

4 Research Method

4.1 Participants

The population for this study is a group of 3122 first year students who are enrolled at the Vaal Triangle Campus of the North-West University in South Africa. A non-probability sampling technique was used to obtain a sample target group of 509 participants from the stated population. The target group was established by identifying a first year course with a large number of enrolments in order to include as many first year female students as possible. The course that was identified was suitable for the study because of the variety of qualifications the students taking this course, were enrolled for. However, it was established that none of the students were enrolled for an education qualification. Therefore the target group was expanded to include a group of first year female students enrolled for an education qualification. The first year female students who are currently enrolled for ICT related qualifications were excluded from this study since the objective of this study was to analyze the perceptions of female students who are not enrolled for ICT-related qualifications.

4.2 Data collection - questionnaire

A quantitative approach was followed using a questionnaire as the survey instrument. The questions used in the questionnaire were compiled from several published papers related to the perceptions of female students on ICT-related careers (Pretorius & deVilliers, 2009; Baggit, 2010). Questions were formulated with the objective of identifying possible reasons why female students are not inclined to pursue a career in ICT.

Demographic data

Demographics of the participants were asked to establish the composition of the group in terms of race, nationality, native language, etc. Some of the questions asked included

To what racial group do you belong?

What is your nationality?

⁹ The Higher Education Management and Information System (HEMIS) database of the South African Department of Education.

Previous engagement with computers

A few questions were asked on the previous encounters of the participants with computers i.e.

Did you take IT (Information Technology) as a subject at school?

Did you take CAT (Computer Application Technology) as a subject at school?

The purpose of asking these questions was to establish the role computers had on the participant's lives up to now and to what extent they were confronted with ICT at school and at home.

Awareness of ICT-related fields of study

Three questions were asked to determine the participant's awareness of three of the most prominent ICT-related fields of study they can enroll for at most institutions for higher education.

Have you ever heard about Computer Science as a field of study?

Have you ever heard about Information Systems as a field of study?

Have you ever heard about Information Technology as a field of study?

Perceptions on ICT professions

In this section nine questions were asked to determine the participant's perceptions of computer professions. The Lickert Scale was used with five possible responses.

Strongly agree Agree Neutral/No idea Disagree Strongly disagree

Some examples of the questions that were asked included:

I think computer professions and qualifications are more difficult than other areas.

I think computer professions and computer related fields of study are boring.

Influence of education experiences

The purpose of questions in this section was to get a sense of the influence that the school could have had on the participant's perception of ICT.

The high school I attended had excellent computer facilities.

I was counselled in the high school about computer-related education and professions.

How perceptions on ICT was formed

The literature review revealed several factors that could influence the perceptions of people on ICT. The following six possible factors were listed:

Parents, teacher, career counselor, friends, media and the Internet.

Participants could select more than one of these items from the list that had a significant influence on the degree they have enrolled for.

Lastly in an open ended question, the participants were asked to write any other

remarks or view they might have on ICT and possible reasons why they did not enroll for an ICT qualification.

The pilot questionnaire was tested by a group of 17 third year ICT students. Some minor changes were suggested and made, after which it was distributed for completion to the members of the sample target group.

5. Findings

Demographic information

Table 1 shows a summary of the demographic information of the sample target group of students.

Table 1. Demographics of sample target group

Aspect	Figure
Average age:	20,6 years
South African Citizens:	98%

The racial composition of the South African society is well represented in the target group of students who participated in the study. Figure 2 illustrates the composition of the participants indicating a majority of black participants.

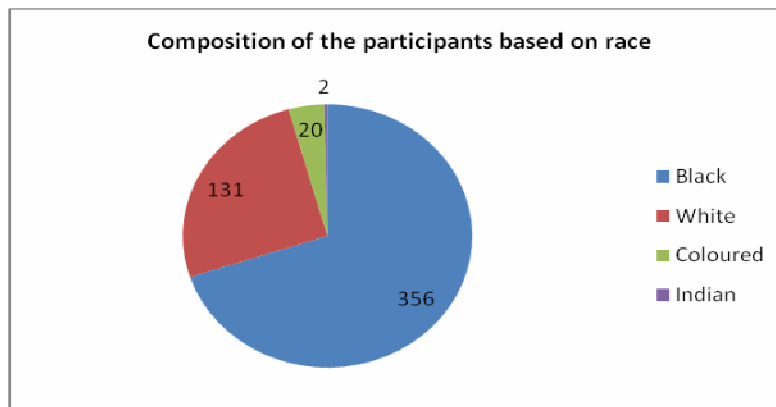


Figure 2. Composition of sample target group based on race

Figure 3 summarizes the degrees that the participants in the research are enrolled for.

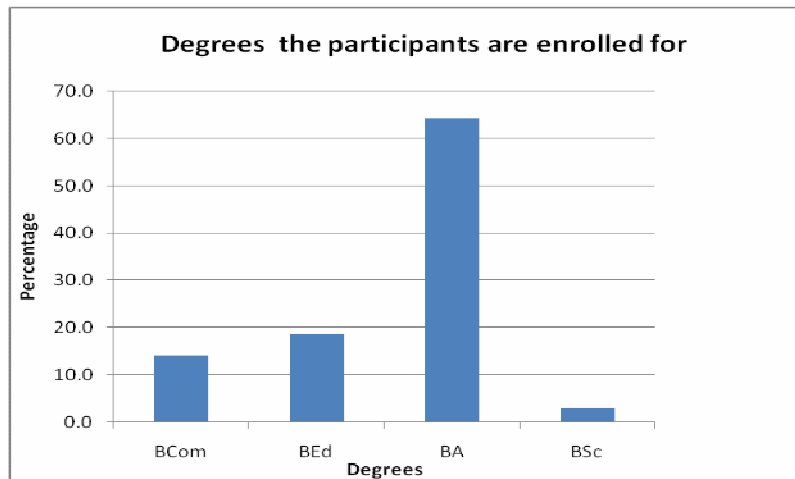


Figure 3. Indicates the composition of the sample target group based on qualifications enrolled for.

Previous engagement with computers

Table 2 summarizes the previous engagement the participants had with computers and computer related experiences. Information Technology (IT) and Computer application Technology (CAT) are two subjects offered at school level. The content of IT focuses on programming skills while CAT focuses on computer literacy and end user skills.

Table 2. Sample target group computer engagement

Aspect	Figure
IT as a school subject	4,5%
CAT as a school subject	22,3%
Have a computer at home	70,9%
Average number of years using a computer	6,2 years
Students with family members employed in ICT profession	16,4%

As it was felt that having a computer at home might influence the perceptions of students and therefore the question was added to the questionnaire. Figure 2 illustrates the obtained answers, indicating that more than half of all the racial groups have computers at home. About 70% of the participants have computers at home. Lack of involvement with computers as a user is therefore not a major contributing factor towards the decreasing number of ICT enrollments of female students. However lack of involvement with computers at a more advanced level e.g. family members in ICT professions or taking IT at school can contribute to the fact that the many of the participants are not aware of the variety of ICT related career opportunities they can enroll for.

Figure 4 shows that even though black female students make up the majority part of the sample target group, about 40% of them do not have computers at home. This aspect could possibly contribute towards female students not enrolling for ICT.

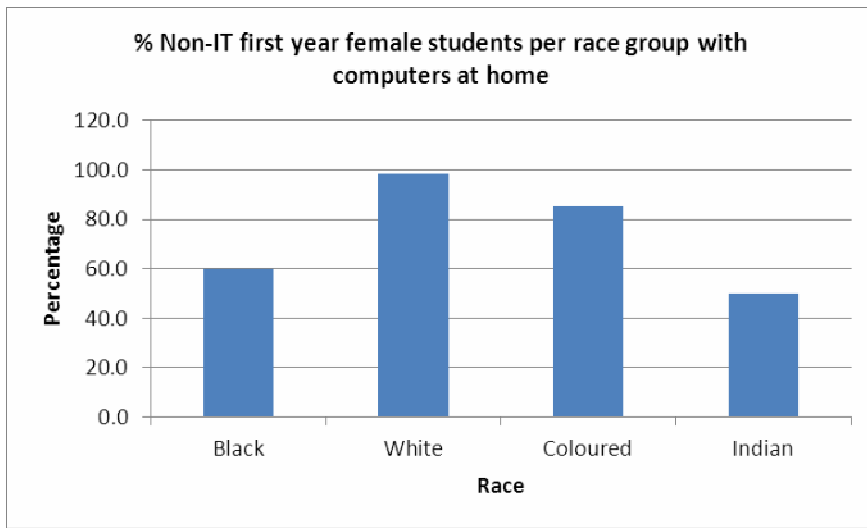


Figure 4 % Non-IT first year female students per race group with computers at home

Although a reasonable number of participants indicated that they know about computer science (CS) and information technology(IT) as possible fields of study, barely 60% on average indicated that they know about information systems(IS) as a possible field of study.

Figure 5 indicates the difference in knowledge of IT, CS and IS as fields of study per racial group. The high percentage of participants that know about IT can be explained by the fact that it is presented as a field of study on the Vaal Triangle Campus. The content of Information Systems field of study entails the soft issues of computing. Making female students aware of Information Systems as a field of study could contribute towards an increased number of female enrollments in ICT. Universities that introduced IS to the degrees they offer have reported a dramatic increase in student numbers.

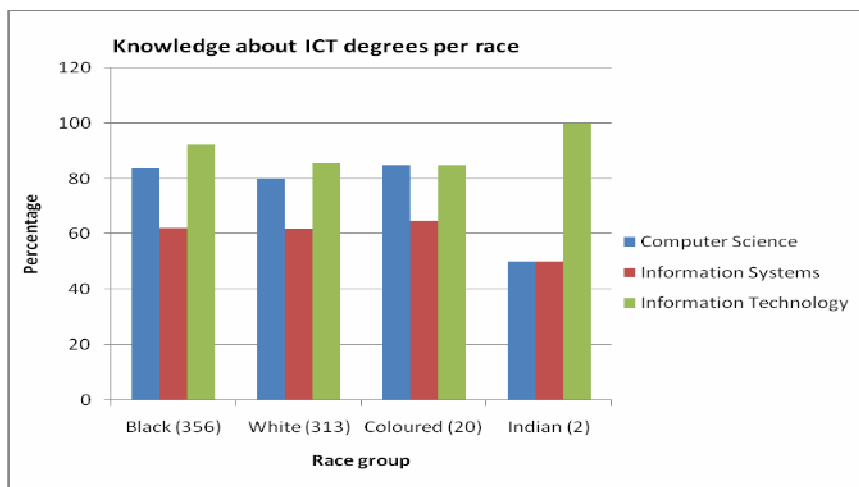


Figure 5. Knowledge about ICT degrees per race

As highlighted in previous research (Lotriet *et al.*, 2010), poor mathematics performance continues to remain a problem. Nearly all participants indicated an insufficient mathematics mark, a problem which is compounded by the subject mathematical literacy. Mathematical literacy does not provide a sufficient foundation for tertiary work, and seems not to be communicated to the young adults at the relevant stages of their secondary education. The Vaal Triangle Campus has tried to address this shortcoming by presenting a bridging course at the start of the year. If students perform sufficiently in this course, they are given access to an extended degree course (4 years instead of 3), in which a better mathematical foundation is formed, before moving on to the ICT related subjects.

As mathematics is a prerequisite for ICT related courses, it can be argued that improving mathematics performance will have a significant impact on the number of ICT graduates. Another alarming fact is that more than 20% of participants took IT related subjects at secondary level of education, but were not pursuing it at tertiary level, or were hampered by poor mathematics performance. Figure 6 summarizes the five aspects regarding influences that formed part of this study.

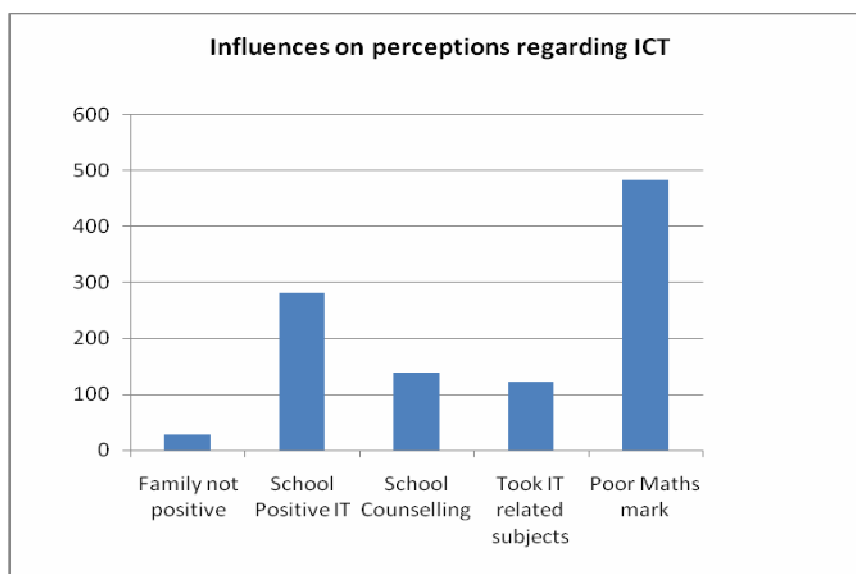


Figure 6. Influences on perceptions regarding ICT

When the participants were asked which people influenced their perceptions regarding ICT, they were allowed to select more than option. The encouragement that young adults receive from others to pursue a career in ICT plays a major role in determining whether they decide to pursue an ICT career or not (Zarrett & Malanchuk, 2005). As the media and the Internet are the most difficult (if not impossible) to influence, it can be argued that teachers should be the main focus in trying to change the negative perceptions regarding ICT as a career. According to Sainz *et al.* (2012), parents and teachers tend to assign negative stereotypes to ICT professions, thereby influencing the young adults negatively. By focusing on changing the perceptions of teachers, it will inevitably have an impact on parents and friends as well. Figure 7 summarizes the number of responses per influence.

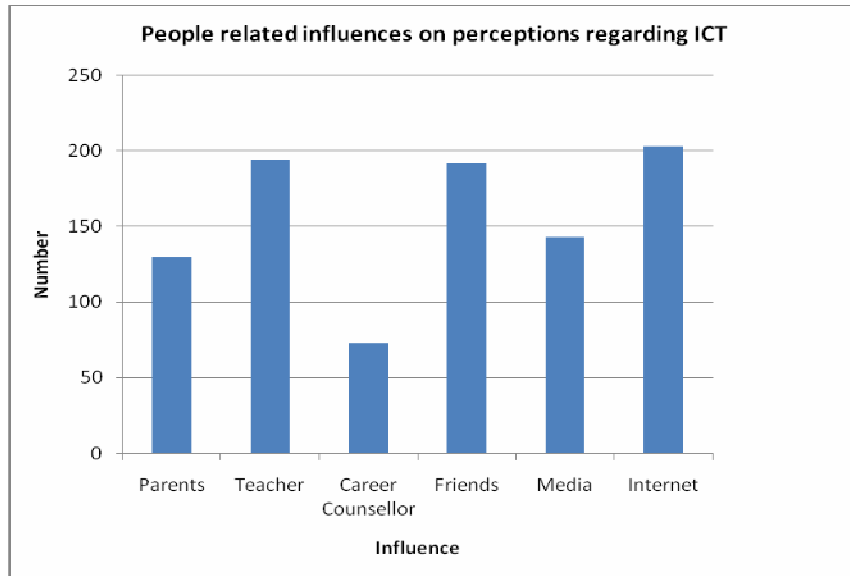


Figure 7. People related influences on perceptions regarding ICT

Although not many students responded to the open ended question on the reasons why they did not enroll for an ICT qualification, those who did respond indicated that their school achievement in mathematics was the only reason why they could not enroll for an ICT qualification.

6. Conclusion and Recommendations

The existence of an ICT skills shortage has been well documented, not only in South Africa, but globally. Unfortunately the shortage is only expected to worsen; therefore interventions and action plans will have to be put in place as soon as possible.

This research has identified the secondary education environment as a major contributor to negative perceptions regarding ICT professions. This is supported by the South African Department of Education, who identified ICT education as a priority in the Birchwood Declaration of 2007. The research highlighted poor mathematics and the perceptions of teachers as major contributing factors to whether young adults choose to enroll for ICT related qualifications or not. Addressing the poor mathematics performance should already start at the primary school level, as a proper foundation will have a major impact during secondary school. It also seems as though teachers and young adults are not aware of the implications of having mathematical literacy instead of mathematics. This can be addressed along with the negative perceptions regarding ICT by educating those in influential roles. It can be accomplished by including it in any educational related qualification, by having specialists to provide guidance to those interested in tertiary education, having teachers attend workshops at local or regional universities or universities of technology, or by discussing it in newsletters or communications distributed directly to schools.

Future research can include verifying whether the findings remain constant throughout South Africa, developing interventions to address the identified problems, and measuring and documenting the effect of implemented interventions.

References

- Battig, M.E. 2010. Piltown Man or Inconvenient Truth? A Two-year Study of Student Perceptions about Computing. *Information Systems Education Journal*, Volume 8, No.33.
- Bissell, C., Chapman, D., Herman, C. and Robinson, L., 2003. Still a gendered technology? Issues in teaching information and communication technologies at the UK Open University. *European journal of engineering education*, Volume 28, No. 1, 27–35.
- Clayton KL., von Hellens LA., Nielsen SH., 2009. Gender Stereotypes Prevail in ICT; a Research Review. SIGMIS-CPR'09, May 28–30
- Denner J., Bean S., Martinez J., 2009. The Girl Game Company: Engaging Latina Girls in Information Technology. *Afterschool Matters*, No. 8, 25-35.
- Freeman, P., Aspray, W., 1999. The Supply of Information Technology Workers in the United States, Computing Research Association, Washington, D.C., http://www.cra.org/reports/wits/chapter_7.html.
- Gallivan, M., Adya, M., Ahuja, M., Hoonakker, P., Woszczyński, A., 2006. Workforce Diversity in the IT Profession: Recognizing and Resolving the Shortage of Women and Minority Employees. *Proceedings of the 2006 ACM SIGMIS CPR conference on computer personnel research: Forty four years of computer personnel research: achievements, challenges & the future*, pp. 44 – 45.
- Kirlidog, M., Zeeman M., 2011, Equity in the South African Education after Apartheid. *IEEE TECHNOLOGY AND SOCIETY MAGAZINE* March, 47-55
- Lomerson WL., Pollacia LF., 2006. Declining CIS Enrollment: An Examination of Pre-College Factors. *Information Systems Education Journal*, Volume 4, No. 35. <http://isedj.org/4/35/>. ISSN: 1545-679X.
- Lotriet, H. H., Matthee, M. C., Alexander, P. M., 2010. Challenges in Ascertaining ICT Skills Requirements in South Africa. *South African Computer Journal*, No. 46, pp. 38 – 48.
- McKinney, V.R., Wilson, D.D., Brooks, N., O'Leary-Kelly, A., Hardgrave, B., 2008. Women and men in the IT profession: Fewer women entering IT drive the underrepresentation problem, *Communications of the ACM*, Volume 51, No. 2, 81-84.
- McKinsey Quarterly. 2010. Moving women to the top: McKinsey Global Survey results Available: http://www.mckinseyquarterly.com/Moving_women_to_the_top_McKinsey_Global_Survey_results_2686 (Accessed May 25 2012).
- Meredyth, D. et al, 1999. Real Time: Computers, Change and Schooling; National Sample Study of the IT Skills of Australian School Students, a project funded by the

Commonwealth Department of Education, Training and Youth Affairs.
<http://www.detya.gov.au/archive/schools/Publications/1999/realtime.pdf>.

Nelson, K. and Veltri, N., 2011. Women in Information Technology: A Person-Process context-Time Framework. *ECIS 2011 Proceedings*. Paper 53.

Pretorius H.W., de Villiers C., 2009. An analysis of the international discourse about women in Information Technology. *SAICSIT '09*, 12-14 October 2009, Riverside, Vanderbijlpark, South Africa.

Ramsey N., McCorduck P., 2005. Where are the Women in Information Technology? Report of Literature Search and Interviews for National Center for Women & Information Technology, University of Colorado, Boulder, February.

Sainz, M., Palmen, R. & Garcia-Cuesta, S., 2012. Parental and Secondary School Teachers' Perceptions of ICT Professionals, Gender Differences and their Role in the Choice of Studies. *Sex Roles*, No. 66, pp. 235 – 249.

Steele, C., 1997. A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist*, 52, 6, 613-629

Varma, R., 2007. Women in computing: The role of Geek Culture, *Science as Culture*, Volume 16, No. 4, 359-376.

Varma R. and Hahn H., 2008. Gender and the pipeline metaphor in computing, *European Journal of Engineering Education*, Volume 33, No. 1, 3-11.

von Hellens L., Nielsen S., Beekhuyzen J., 2011. Women Working in the IT Industry: Challenges for the New Millennium. *Journal Of Business & Economics Research*, Volume 1 No. 11, 21-32.

Zarrett, N. R., Malanchuk, O., 2005. Who's Computing? Gender and Race Differences in Young Adults' Decisions to Pursue an Information Technology Career. *New Directions for Child and Adolescent Development*, No. 110, pp. 65 – 84.