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TOWARDS A THEORETICAL FRAMEWORK FOR UNDERSTANDING THE MOTIVATIONS OF FEMALE SOUTH AFRICAN UNIVERSITY STUDENTS TO STUDY INFORMATION TECHNOLOGY

by

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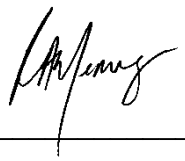
Signature 

20 November 2020

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TOWARDS A THEORETICAL FRAMEWORK FOR UNDERSTANDING THE MOTIVATIONS OF FEMALE SOUTH AFRICAN UNIVERSITY STUDENTS TO STUDY INFORMATION TECHNOLOGY

ABSTRACT

The considerable growth of the global information technology (IT) sector demands a supply of suitable qualified workers. While universities are an important source of IT graduates, the number needs to be increased, especially those of women and underrepresented minorities.

This study investigates the factors that influence the decision of female South African university students to study Information Technology. An explanatory sequential mixed methods approach is followed. It consists of three phases of data collection: a quantitative phase consisting of two surveys (n=1518 and n=3289), a qualitative phase consisting of interviews (n=21) and another quantitative phase consisting of an open-ended questionnaire (n=253). Data collection across all phases is supported by a framework based on the Individual Differences Theory of Gender and IT.

We found that female students from the African, Coloured and Asian population groups were twice as likely to choose an IT-related degree than female students from the White population group. This was possible due to the unique interaction of various relevant constructs from the framework. Students of lower socio-economic status availed themselves of government-sponsored bursaries and pursued IT studies fuelled by the opportunities in the IT industry. Tertiary institutions that offered introductory IT courses presented this opportunity to students who have no IT background. Strong female role-models destroyed any prejudices toward women in the IT workplace. IT majors were carefully chosen to exclude the overtly technical degrees such as Computer Science and Computer Engineering and favoured IT qualifications such as Informatics and Publishing.

Using Pierre Bourdieu's social theory as a lens to interpret the results, this study concludes that Bourdieu's argument regarding the perpetuation of social status via education does not hold in the case of information technology studies. In the IT field, students are assessed on merit and not on cultural habitus. A qualification in IT is attainable by any interested and suitably talented individual, irrespective of race, gender or socio-economic status. Implications for practice are that IT studies need to be promoted as attainable and promising excellent career prospects.

Keywords: broadening participation, diversity, gender, gender and information systems theory, gender imbalance, gender theory, IDT, Individual Differences Theory of Gender and Information Technology, IT major, IT study choice, IT workforce.

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To my mother Marié - thank you for walking the road with me. "Trouble shared is half the trouble, joy shared is double the joy".

To my children Linda and Willem, I am so glad we have each other. May you use every opportunity to better your life.

To my late husband Willem - thank you for providing for us so well. I would not have been able to attempt this journey if not for you.

Table of Abbreviations:

CM: Computer Major

CS&E: Computer Science and Engineering

CGS: Continuing-generation students

FGS: First-generation students

ICT : Information and Communication Technology

IDT : Individual Differences Theory of Gender and Information Technology

IS : Information Systems

IT : Information Technology

NSFAS: National Student Financial Aid Scheme

SDG: Sustainable Development Goals

SET: Science, Engineering and Technology

STEM: Science, Technology, Engineering and Mathematics

Terms

Computer Major	Computer-related qualifications that allow students to study both the hardware and software aspects of computer technology.
Continuing-generation student	A student who has at least one parent who has attended university him/herself.
Essentialism	A theoretical perspective arguing the existence of "essential differences" between males and females by proposing an underlying difference in the male nature as opposed to the female nature.
First-generation student	A student who is the first in the family to attend university.
Individual Differences Theory of Gender and IT (IDT)	A social theory developed by Trauth (2002) that focuses on within-group rather than between-group differences to explain variations in male and female relationships with information technology. This theory posits that the under representation of women in IT can best be explained by considering individual characteristics and individual influences that result in individual and varied responses to generalised environmental influences on women.
Information economy	This term is used synonymously with the terms 'information sector', 'IT workforce', 'IT sector' and 'IT economy' (Trauth, Quesenberry, & Yeo, 2008)
Non-Computer Major	Non-computer-related qualifications such as Medicine, Law or the Humanities.
Paradigm	"Universally recognised scientific achievements that for a time provide model problems and solutions to a community of practitioners" (Burrell and Morgan, 1979, p. 37)
Social Construction	A theoretical perspective that focuses on social processes and interactions in the shaping of actors. It argues that technology, which is socially constructed as a masculine domain, is in conflict with the socially constructed feminine identity.

1 INTRODUCTION

1.1 BACKGROUND INFORMATION

"A diversity of thought, perspective and culture is important in any field, not just engineering"

Sarah Friar, Chief Financial Officer at Square

The World Economic Forum surveyed a number of the world's largest employers about the changes that technology and society will have on their industries up to the year 2020. One of the findings regarding their human resource strategies was that there are no more excuses for talent diversity. They call for action on tackling barriers to workforce diversity because of the proven benefits of team diversity together with the increasing difficulties in finding talent (World Economic Forum, 2018)(World Economic Forum, 2018). Talent and workforce diversity in the information technology (IT)[1] industry particularly, is under severe pressure. In a study on IT trends in almost 800 organisations, the Society for Information Management reported the IT Talent Shortage to be among their top two "worrisome" IT management issues of the year (Kappelman et al., 2019).

Hayes and Bigler (2014) identified two emerging trends from worldwide efforts to produce a sufficiently large technology workforce. The first concerns globalisation and subsequent cultural diversity issues, and the second concerns the number of women who pursue careers in technology. Increasing globalisation means that students are internationally mobile and able to gain their qualifications at perceived high-ranking institutions outside their country of birth. Globalisation also demands that graduates are prepared and able to work in different countries with culturally diverse development teams, as well as culturally diverse users

[1] The generic term IT is used as a blanket term to cover all derivations of information and communication technology, computer science and information systems fields in the area of discipline.

(Patil, 2005). The second trend concerns the lingering under-representation of women in tertiary IT majors.

Various reasons are proposed for the lack of females pursuing IT majors. These include perceptions regarding the difficulty of the IT subjects and perceptions regarding the image of the professionals as nerds or geeks (Ridley & Young, 2012; Mui, Tee & Sien, 2013; Ashcraft, Eger & Friend, 2012). The secondary school system is a contributing factor to the persistently low number of students in post-secondary IT education. Inadequate computer science education at secondary school level leads to a decrease in the number of students who enrol for IT studies (Wilson, Sudol, Stephenson, Stehlik, Acm & Csta, 2011).

A significant number and variety of interventions were put in place to introduce girls to IT (Fisher, Lang, Craig & Forgasz, 2015; Von Hellens, Trauth & Fisher, 2012; Trauth, 2012; Christensen, Knezek & Tyler-Wood, 2014; Clayton, 2007). The effectiveness of the outreach strategies are however complicated by the volume of potential influencing factors and their possible interdependencies (Google, 2014). Ultimately the number of females who commence and continue pursuing IT studies and occupations remains low.

Recent years have seen an increase in research efforts aimed at understanding female disinterest in IT education, moving away from gender essentialism to a wider understanding of socio-cultural issues affecting participation (Nix & Perez-Felkner, 2019). Ashcraft, Eger and Friend (2012, p. 30) call for future research that takes a more in-depth look at intersections of race, gender, class, ability, and sexuality, saying that “...variation within sex is often greater than variation between the sexes".

In a Management Information Systems Quarterly special issue on “ICT and Social Challenges”, Oreglia and Srinivasan (2016) drew attention to the necessity for more theoretically sophisticated research on gender and IS. They agreed with Adam, Howcroft and Richardson (2004) who criticised the existing gender and technology scholarship for focusing too narrowly on gender as a binary variable in determining differences in behaviour, while ignoring variables such as age, class and ethnicity. They mention Corneliussen (2005), Pozzebon, Mackrell and Nielsen (2014), Tapia (2006) and Trauth

(2013a) as producing theoretically sophisticated research on gender and IS, Adam *et al.* *(*2006), Howcroft and Trauth (2008) and Trauth and Howcroft (2006), as integrating critical theory in IS research, and D'Mello and Eriksen (2010), Kvasny (2006) and Ravishankar, Pan and Meyers (2012) for investigating race in IS. However, they emphasise that these studies constitute the exception rather than the rule.

To investigate the uptake of IT majors among female students, it would therefore be expedient to heed the call of Trauth, Quesenberry and Huang (2008):

> "The under-representation of women in the IT workforce, coupled with increased cultural diversity emanating from the globalization of the IT sector, highlights a problem both for the practice and the research domains of the IT field. The problem for practice is to develop interventions to increase the under-representation of women. The problem for research is to theorize the issue and compile data in such a way that actionable interventions can result" (Trauth et al., 2008, p. 2).

1.2 PROBLEM STATEMENT

The problem addressed in this study is the lack of understanding of the low uptake of IT majors and especially by female first-year students. This contributes to the IT skills shortage and represents a missed opportunity for a stable job and above average income. The first aspect is not only a problem in terms of too few IT workers, but also in terms of workforce diversity. A diverse workforce invariably creates technological innovations that better meet the needs of a diverse society. It also helps us address a broader array of social problems and inequities (Ashcraft et al., 2016). The second aspect, income, is critical in a socio-economic environment such as a developing country. In an emerging market, having a stable income makes the difference between living in poverty and participating more equitably in society (Nattrass and Seekings, 2014; Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs), 2016).

This study is performed in South Africa, which is a developing country and which also currently has the highest inequality rates in the world (a Gini coefficient of 0.63) (Scott,

2019). Despite 26 years of democracy, the country is still plagued by political inefficiencies and socio-economic challenges. The education system, originally shaped by social and economic inequalities of class, race and gender (Badat, 2007), is still asymmetrical. Poor performance in the maths and science education in schools restricts enrolments in science, engineering and technology (SET) qualifications at tertiary institutions. The 2018 JCSE-IITPSA ICT Skills Survey raises concern that the country's prolonged failure to improve the numbers of science, technology, engineering and mathematics (STEM) graduates is a threat to South Africa's ability to counter cybercrime attacks and maintain a strong ICT industry (Schofield, 2018).

Exacerbating the problem of low numbers of tertiary STEM entrants, is the fact that very few of the STEM entrants choose to register for IT majors. In the gender ratios of tertiary STEM cohorts in the past few years, the number of female students has overtaken the number of male students. Yet the ratio of female students registering for IT majors is much smaller than males (Speiser & Lang, 2019). The reasons for this phenomenon are not well understood and neither are any possible practical interventions to effect improvements.

Investigating a way to greater inclusion in countries like South Africa, demands finer-grained data collection than gender data only. Racial and ethnic data is also necessary to avoid missing important intersectional differences (Booysen & Nkomo, 2010). There is also general consensus that this type of research will be ongoing, due to the IT skills that will remain in demand (de Villiers et al., 2012).

Understanding a problem does not mean we can solve it, but the findings of this study could indicate potentially promising interventions that will help policy makers, parents and prospective students in decision-making that is potentially advantageous to all. The underlying theoretical framework of this study could contribute to informing researchers who wish to perform a similar study in a different setting. So too can the mixed methods approach described here inform researchers who wish to enrich their understanding of a phenomenon by collecting more than one type of data.

1.3 PURPOSE OF THE STUDY

The purpose of this study is to compile a theoretical framework of determinants of interest in IT majors, to aid our understanding of female university students majoring in IT, with a view to increasing their participation. To ensure a rigorous process, the first step is to identify a contemporary theoretical underpinning for research into gender and IT. The research framework is then adjusted to focus on the phenomenon of university major choice and used to gather both qualitative and quantitative data on South African students' choice of IT major. The data from the various phases are merged to arrive at a more informed view of factors that influence individuals' choice of major, as well as ways to encourage female students to register for IT majors.

1.4 RESEARCH QUESTIONS

The main research question driving this study is:

How can we compile a theoretical framework for understanding the motivations of female South African university students to study Information Technology?

The following sub-questions attempt to answer the main question:

- What is an appropriate framework to study the under-representation of females in tertiary IT qualifications?
    - What contemporary frameworks are available to study the under-representation of females in the IT industry?
    - How can these frameworks be harnessed to specifically address the career choice phase of the career lifecycle?

- How might such a framework of IT study choice be applied to the uniquely South African context?

1.5 ASSUMPTIONS

Participants in this study are registered students at a residential university and, as such, participated in the surveys on a face-to-face basis. It can be assumed that their responses on the study choice questions are honest and accurate since they had recently completed the process of deciding on a major, and that the issues they encountered are relevant and easily recalled.

1.6 LIMITATIONS

The data for this study was collected at one metropolitan university. This is only one type of many institutions offering a vast array of different types of IT qualifications. In addition, although the student demographics of the university where the study was performed, is representative of the country, the reliability of the study will be improved if data is collected from two or more universities countrywide. Another limitation pertains the population of this study. No Engineering or Medical students were included in the survey due to differing timetables and lecture locations.

1.7 BRIEF CHAPTER OVERVIEW

Figure 1 provides an overview of the chapters in this document.

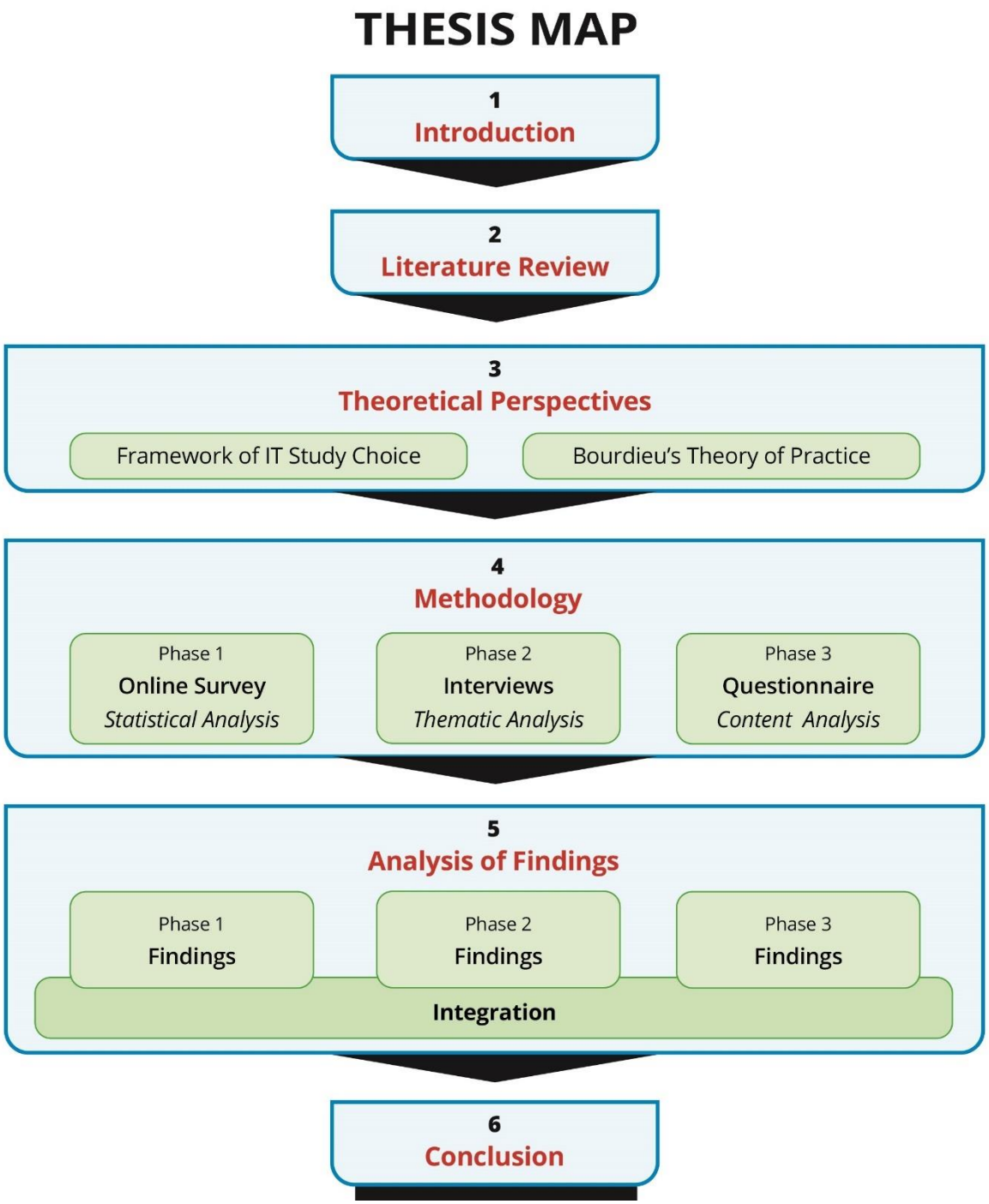


Figure 1: Thesis Map

The thesis is structured as following: Chapter 1 lays the foundation for the study by describing the background and the purpose of the study, as well as defining the research questions. Chapter 2 grounds the study by performing a systematic literature review on factors that have an influence on students' uptake of an information technology major.

Chapter 3 describes the search for a contemporary theory to best help us understand the phenomenon. The chapter starts by identifying a theory to inform data collection, and ends by summarising a second theory that was used in the interpretation of the data.

Chapter 4 describes how the data was collected. The identified theory formed a legitimate base upon which the data was built, with the first layer being quantitative data and the second layer being qualitative data. A third (qualitative) phase, which became necessary to explore a thread that became apparent during the second phase, is then described. Chapter 5 provides an analysis of the data collected for each phase, as well as an integration of data from all three phases. Chapter 6 brings the findings together into a discussion and conclusion of the research.

2 LITERATURE REVIEW

2.1 INTRODUCTION

A systematic literature review was performed to identify relevant peer-reviewed studies on the topic of factors that influence female participation in postsecondary computing education.

A systematic review is defined as, **"**A review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyse data from the studies that are included in the review. Statistical methods (meta-analysis) may or may not be used to analyse and summarise the results of the included studies" (Siddaway, 2014, p. 1).

The aim of this chapter is to identify and summarise what is known about the factors influencing students' uptake of an information technology major following their secondary education. Properties of the studies were recorded, such as its method (survey or meta-analysis), participants (age, gender, ethnicity, country) and type of publication (journal article, conference proceedings or grey literature). Findings were recorded, as well as aspects that remained unexplained. Recommendations for practice and calls for future research were also summarised. The review was performed according to the protocol described below.

2.2 SYSTEMATIC LITERATURE REVIEW PROTOCOL

1. Title of project: Towards a theoretical framework for understanding the motivations of female South African university students to major in Information Technology	
Research Question	What factors affect the decision of female students to major in IT?

Terminology:

Factors – antecedents to a scholar deciding on an IT major**.**

Female – Females are under-represented in the IT workforce.

Major in IT – a major in a degree in the information and communication technologies, implies a major for a university degree that has a strong computer science component. The general term is computer-related major, and specific fields of study are computer science, information technology, computer engineering and informatics.

Nonmajor – This indicates a computer-related course which is taken for degree-granting purposes, but which is part of a non-computer-related degree.

Undergraduates – The population for this study is first-year students registered at a university, or intending to register at a university. The population excludes adults registering for, or changing to computing majors.

Developing country – This study is performed in a country defined as being moderately developed. Former UN Secretary-General Kofi Annan defined a developed country as one which "… allows all its citizens to enjoy a free and healthy life in a safe environment" (United Nations, 2000, p. 2). South Africa is also defined as being a newly industrialised country, but suffers from low per capita income levels. In 2016 the World Bank decided to no longer distinguish between "developed" and "developing" countries, but to classify countries into four groups based on their Gross National Income per capita. The low-income countries were defined as being those with A GNI of $995 (US dollars) or less.

STEM – Science, Technology, Engineering and Mathematics. The STEM field consists of the IT field and also many subjects unrelated to computer science and information technology and, therefore, the term STEM (or its equivalents) should be excluded from this study due to the underlying difference between the IT subject field and the other STEM subject fields (non- computer-related majors). "This tradition within the literature is important given that research has shown that students pursuing a computer science undergraduate degree are quite distinct from other STEM students with respect to background characteristics, self-ratings, and career aspirations" (Lehman et al., 2017, p. 260).

	Exclusions : Any IT workforce issues are excluded since this review focuses on secondary school students and first-year university students and their choice of major.	
Problem	Size of IT workforce inadequate to meet demand. Lack of diversity inhibits relevance and quality of proposed solutions.	
Objectives	Find and investigate research performed on gender and information technology to identify relevant literature and summarise findings.	
Keywords	Gender, information technology, computer science, major.	
Search string	Gender AND information AND technology AND studies in Title, Abstract or Keywords Information technology or computer And Gender or female or women or diversity And Graduate or Major or Degree or Qualification *Do not use "Study choice"* NOT "Career", "Work", "this study" Time : From 1970-2019	
Databases	ACM digital library EBSCO host web	The EBSCO search included the following databases: Academic Search Complete Africa-Wide Information Business Source Complete eBook Collection (EBSCO host) EconLit E-Journals ERIC Library & Information Science Source Library, Information Science & Technology Abstracts

	Science Direct IEEE explore Scopus Google Scholar	MathSciNet via EBSCOhost Newspaper Source PsycARTICLES PsycINFO TOCPremier
	A hand search was performed by inspecting the references of each identified journal article for further pertinent publications	
Inclusion / Exclusion criteria for considering studies in the review	Inclusion criteria Gender or female or girl or woman First-year or freshman University student factors or influences stereotypes IT major registration IT degree or qualification choice or registration English language Peer-reviewed articles Conference papers Books	Exclusion criteria Career / Workforce aspects Non-degree IT qualifications Non-English language literature

Before starting the database searches, the review question was deconstructed to identify keywords and construct the search terms.

Identifying relevant search terms

The main research question was the following:

What factors affect the decision of female students to major in IT?

The search terms were constructed according to concepts “females”, “major” and “information technology”. The terms are illustrated in Table 1.

Table 1: Components of review question and keywords

	String 1	String 2	String 3	Time
	AND	AND	AND	AND
OR	Gender	Information technology	studies	1970 to 2019
OR	Woman		degree	
OR	Female		grad	
OR	Girl			
OR	Diversity			
NOT			Career	
NOT			Study choice	
NOT			Work	
NOT			“This study”	

Notes:

- Only the term “information technology” was used and not the term STEM. There is a need to disaggregate information technology (IT) from STEM in the research results, since the IT students’ reasons for choice of major, differ markedly from those of the STEM students. A number of studies do disambiguate between these two terms and they were included due to the fact that the term “information technology” appears in their text.
- All searches performed were within the time period 1970 to 2019.
- The term “study choice” was an explicit exclusion from the search terms since the term “choice of major” is more widely used. Also the word “study” appears in most academic literature, where the content of the paper is described as “this study…”. Excluding the words “this study” or “study choice” automatically excludes irrelevant publications.

- The Google search using the same keywords as above, returned a count in the millions. It was necessary to limit this search using various exclusions.

The following criteria were applied to assess the inclusion of a publication in this systematic literature review:

- Is the population of the publication **scholars** or **first-year university students**?
- Does the publication address students enrolled in, or intending to **enrol for a computer-related major**? Computer-related majors are considered to be degrees such as information technology, informatics, computer science and computer engineering.
- Does the publication discuss issues around **gender** and **underrepresented minorities** in the field of IT studies?
- Does the publication address aspects that **influence the decision to major** in the IT field? (i.e. Any aspects that influenced a student to enrol for a computer-related major).

2.3 FIRST DATABASE SEARCH

The databases searched were the ACM digital library, EBSCO host web, Science Direct, IEEE explore, Scopus and Google Scholar.

Table 2: Databases searched using the terms in Table 1.

Database	Date	Search Term	From Field	Document Type	# articles found
ACM digital library	21/6/ 2019	Gender AND information AND technology AND studies	Anywhere in article	The ACM Full-Text Collection.	287
	21/6/ 2019	(Same as above)	Anywhere in article	The ACM Guide to Computing literature	1068
EBSCO host web	21/6/ 2019	Gender AND information AND technology AND studies	Anywhere in article	No other limits	249710

	21/6/ 2019	(Same as above)	Anywhere in article	Academic journals	218 058
	21/6/ 2019	(Same as above)	Abstract	Academic journals	1663
	21/6/ 2019	Gender AND “information technology” AND studies. Limit to Full Text and Academic (Peer Reviewed) Journals.	Abstract	See Notes	383
Science Direct	22/6/ 2019	Gender AND information AND technology AND studies	Title, Abstract, Keywords	All	312
IEEE explore	22/6/ 2019	(("Abstract":gender) AND "Abstract":information technology)	Abstract	All	170
Scopus	22/6/ 2019	TITLE-ABS- KEY (gender AND information AND technology AND studies)	Title, Abstract, Keywords	Article or Conference paper	2 782
	22/6/ 2019	TITLE-ABS-KEY (gender AND "information technology" AND studies)	Title, Abstract, Keywords	Article or Conference paper	927
Google Scholar	25/6/ 2019	Gender information technology studies	Anywhere in article	All	3 790 000
	25/6/ 2019	(Same as above)	Title	All	4
	25/6/ 2019	Gender “information technology” studies	Anywhere in article	All	645 000
	25/6/ 2019	Gender “information technology” studies	Title	All	30
	25/6/ 2019	Gender “information technology” studies -"case study" -"this study" -"empirical study" -use -work –workplace	Title	All	28
Note: The EBSCO Host search 16/1/2019 was performed with the following libraries selected : Academic Search Complete, Africa-Wide Information, Business Source Complete, eBook Collection (EBSCOhost), EconLit, E-Journals, ERIC, Library & Information Science Source, Library, Information Science & Technology Abstracts, MathSciNet via EBSCOhost, Newspaper Source, PsycARTICLES, PsycINFO, TOCPremier					

After performing each database search, the results were exported according to each search engine’s format. Most databases offered text file exports in the format of “.csv” (comma-separated values) or “.txt” (text). Google results had to be copied directly into a word processor but could also be downloaded using a third-party tool. The data in these different formats were imported into Excel, and manipulated into a publication per row, starting with the authors and then the titles, followed by the rest of the information.

The literature was then grouped according to source into four groups. i.e. journal articles, conference articles, theses and reports, and books. The first pass through the data consisted

of discarding irrelevant literature according to the title of the publication. The process of identifying relevant publications was expedited by using a number of Excel text extraction and ordering functions. The number of publications thus identified is listed in Table 1.

The second pass judged suitability on the basis of the abstract while the last pass necessitated a quick scan of the body of the publication. The number of publications identified in these two passes, is listed in Table 2 and Table 3 respectively.

Table 3: Number of suitable publications identified after scanning the titles

Database	# articles found	# discarded	# duplicated	# to review
ACM digital library	1 068	995	7	66
EBSCO host web	383	330	20	33
Science Direct	312	294	1	17
IEEE explore	170	146	3	21
Scopus	927	712	0	215
Google Scholar	911	830	0	81
Total	3 771	3 307	31	433

Notes :
Inclusion decisions were based on a population of primary and secondary school learners, first-year university students, their parents and other influencers, as well as various other factors that influence perception toward IT as a career or study choice.

Upon scanning a number of publications identified as such, the researcher realised that an important search term was missing. The term “computer” or “computer science” had been omitted thus far, resulting in a number of important publications missed.

The term “studies” also proved to be unsuitable since most academic publications contained the words “this study”, causing many false inclusions. A more suitable term was found in the word “major”, as in “enrolled in an IT major”.

It was decided to narrow the publication date window and discard all publications dated before the year 2000. This was done to generate a more manageable amount of relevant publications and to allow a focus on the most recent research.

A second search was performed according to the keywords in Table 4.

Table 4: Components of review question and keywords for final search

	String 1	String 2	String 3	Time
		AND	AND	AND
OR	Gender	Information technology	student	2000 to 2019
OR	Woman	Computer science	major	
OR	Girl			
NOT			Career	
NOT			Study choice	
NOT			Work	
NOT			“This study”	

2.4 SECOND DATABASE SEARCH

Table 5: Databases searched using the terms in Table 4.

Database	Date	Search Term	From Field	Document Type	# articles found
ACM digital library	9/7/2019	Searched for record Abstract:(women girl gender) AND record Abstract:("information technology" "computer") AND record Abstract:(student major) *	Abstract	The ACM Full-Text Collection	1704
EBSCO host web	9/7/2019	Search Alert: "AB (women or girl or gender) AND AB ("information technology" or "computer science" or "computer engineering" or comput*) AND AB (major or student) Full Text; Scholarly (Peer Reviewed) Journals; Published Date: 20000101-20191231 on 2019-07-09 05:53 PM" *	Abstract	See Notes	1831

Science Direct	9/7/2019	date: 2000-2019 (women or girl or gender) AND ("information technology" or "computer") AND (student or major)	All	Review Articles Research Articles Conference abstracts	227
IEEE explore	9/7/2019	(((woman or girl or gender) AND "information technology" or "computer science" or "computer engineering") AND major or student) Filters Applied: Conferences Journals 2000 - 2020	Title, Abstract, Keywords	Article or Conference paper	29
Scopus	9/7/2019	TITLE-ABS-KEY (women OR gender) AND TITLE-ABS-KEY ("information technology" OR "computer science" OR "computer engineering") AND TITLE-ABS-KEY (major OR degree) AND DOCTYPE (ar OR cp) AND PUBYEAR > 1999	Title, Abstract, Keywords	Article or Conference paper	766
Google Scholar	9/7/2019	gender "information technology" major computer student -STEM -"case study" -"this study" -"empirical study" -use -work -workplace Search returned 420 items in Google. In order to export the results, "Publish or Perish" was used to run the same query, collect information from Google and export it in a format suitable for Excel. The "Publish or Perish" search produced 229 items since it checks for duplicates and non-English publications.	Keywords	All	420 in Google and 229 in PoP
Note: The EBSCO Host search 16/1/2019 was performed with the following libraries selected : Academic Search Complete, Africa-Wide Information, Business Source Complete, eBook Collection (EBSCOhost), EconLit, E-Journals, ERIC, Library & Information Science Source, Library, Information Science & Technology Abstracts, MathSciNet via EBSCOhost, Newspaper Source, PsycARTICLES, PsycINFO, TOCPremier					

The second database search provided the following numbers of publications:

Table 6: Number of publications identified with database search.

Database	# publications found using search terms
ACM digital library	1704
EBSCO host web	1831
Science Direct	227
IEEE explore	29
Scopus	766
Google Scholar	420
Total	**4977**

Due to the large number of publications retrieved, it was necessary to filter them according to the search terms in the title. This was done in Excel by searching the titles for the keywords. Table 6 lists the subsequent numbers of publications identified for review according to their titles.

Table 7: Number of publications identified with title search.

Database	# publications found with search terms	# discarded	# duplicated	# to review
ACM digital library	1704	1466	11	227
EBSCO host web	1831	1514	18	299
Science Direct	227	161	7	59
IEEE explore	29	18	0	11
Scopus	766	425	5	336
Google Scholar	420	409	0	11
Total	**4977**	**3993**	**41**	**943**

A considerable body of research exists under the topic of “Women in IT”, in part due to the interdisciplinary nature of the field. The decision was therefore made to include mainly peer-reviewed journal publications in the Systematic Literature Review, including relevant literature from a few high-ranking conferences. Literature other than journal and conference papers, such as books, theses and industry or government reports, are grouped under the term “grey literature”. This indicates literature which has not undergone peer review and which is included in the review as published material highly relevant to the topic.

A hand search revealed further publications to include in the review. This led to the inclusion of a few publications dated earlier than the year 2000.

Table 8: Number of publications identified with abstract search.

	Journal articles	Conference papers	Grey literature	Total
# From first pass (Table n)	425	488	30	**943**
# Discarded after scanning abstracts	305	383	27	**715**
# Added from hand search	7	-	-	**7**
# To review	**127**	**105**	**3**	**235**

The numbers of resulting publications eligible for full-text scanning are listed in Table 9.

Table 9: Types of publications identified for full text search.

	Journal articles	Conf papers	Grey literature	All publication types
# from second pass	127	105	3	235
# discarded	50	48	0	98
# to review	**77**	**57**	**3**	**137**

2.5 PRISMA FLOW DIAGRAM

The steps followed in this systematic literature review together with the number of documents involved, are illustrated in Figure 2: PRISMA Flow Diagram.

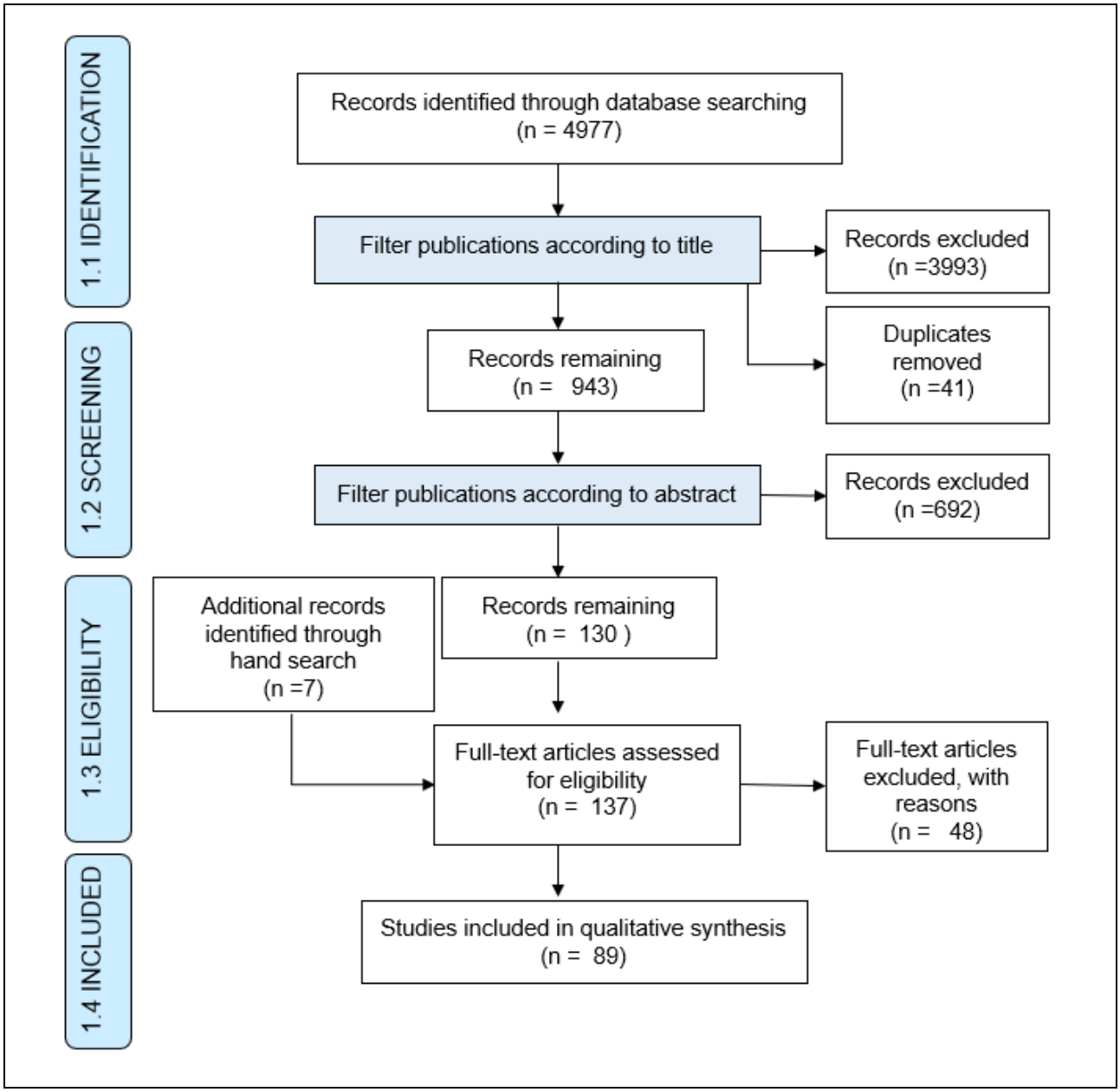


Figure 2: PRISMA Flow Diagram

2.6 QUALITATIVE SYSTEMATIC LITERATURE REVIEW

This systematic literature review produced 89 papers that were listed chronologically from latest date of publication (Appendix A). The full text of each of the eligible articles were scanned and the themes plotted in a matrix according to the paper number. The matrix can be seen in Appendix H. This matrix is also called an evidence table, and is used to identify differences and similarities in the results of the various studies. It assists the researcher to

find patterns in the literature. A diagram can also be used to good effect to illustrate the various concepts, such as an overview of the issues in the current study as can be seen in Figure 3.

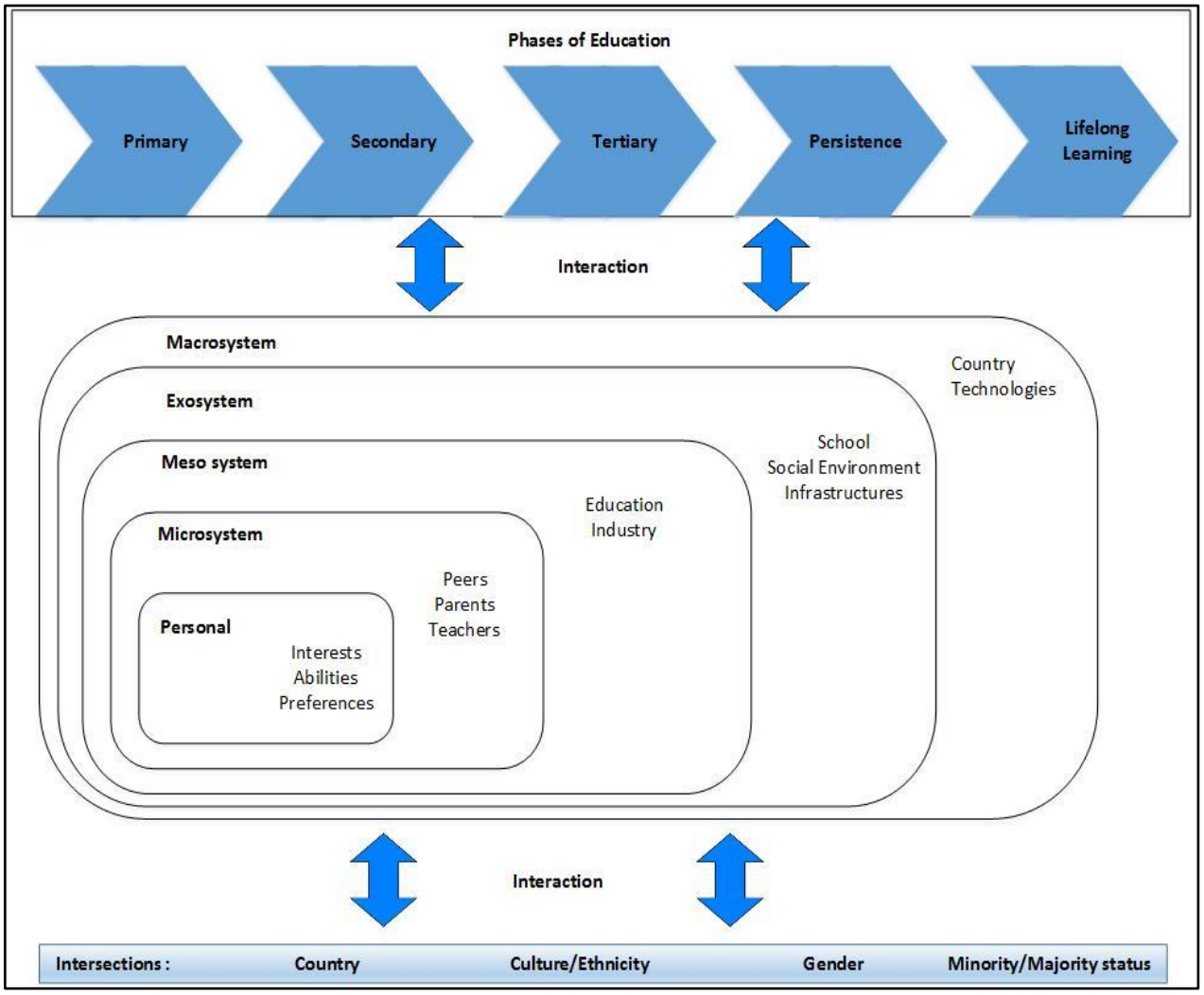


Figure 3: Concepts identified in literature on factors affecting the decision of female students to major in IT.

Various theories were used in the identified literature, one of which is the social psychologist Urie Bronfenbrenner's socio-ecological systems theory. The socio-ecological systems theory describes human development as consisting of aspects from four interconnected systems. These are the macrosystem, the exosystem, the mesosystem and the microsystem, with the macrosystem exerting the most influence (Basham et al., 2010). The

factors that affect the decision of female students to major in IT can resort under any one of the five levels shown. Personal factors are those unique to the individual, and every layer (or “system” as per the diagram) surrounding the person, exerts an influence on the decisions of the individual. Ceci, Williams and Barnett (2009) use the same concept of concentric layers of influence in their framework of causal pathways to math-intensive fields for women. Their “cultural beliefs” correspond to Bronfenbrenner's two outer layers, the exosystem and the macrosystem, their “proximal environment” corresponds to Bronfenbrenner's microsystem, and their “individual” motivation, beliefs and activities correspond with Bronfenbrenner's Personal construct.

Besides the various aspects that influence an individual on a daily basis, every person also progresses along a chronological set of educational milestones (Ahuja, 2002 and Armstrong, Riemenschneider and Giddens, 2018). The choice of career logically precedes the decision of the optimal way to qualify for that career, and these decisions are usually made during the culmination of the individual’s secondary education phase. All the events in an individual’s life that precede tertiary studies, exert an influence on the choice of study major. Lastly, all of these events uniquely interact with the individual’s specific gender, ethnicity, culture and status in society.

2.7 OVERVIEW OF IDENTIFIED LITERATURE

Of the 89 papers included in this study, 75 were studies using primary data and 13 used secondary data. Primary studies comprise the collection and analysis of data and secondary studies comprise analysis of an existing dataset or datasets. Due to the nature of secondary studies, population sizes are much larger than primary studies. Figure 3 represents the primary studies chronologically, while Figure 4 similarly represents the secondary studies. Some of the papers are opinion pieces and use no data, such as study 18. It is therefore excluded from these figures.

Both the primary and secondary study graphs show one study each of unusually large population size. The largest primary data study (S56) makes use of data from public elementary schools of China’s disadvantaged and migrant communities and rural areas. The

aim of the study was to determine whether girls and boys can gain equally from computer-based education. Data from three randomised field experiments of a Computer Assisted Learning program provided data of 9356 elementary school children. Findings were that computer-based learning benefits girls and boys equally. The largest secondary data study (S43) makes use of data from the Cooperative Institutional Research Program which is the largest longitudinal study of American higher education. It comprises more than four decades of student data on demographics, educational experiences, self-concepts and career aspirations. The study assessed mathematical self-concept and whether it has changed over time. Four years' data was used from this dataset, comprising data on more than 353 000 students. The study found that the salience of mathematical self-concept in predicting choice of (amongst others) computer major has diminished among female students, a positive sign which makes it more likely for them to declare a computing major. Study number 87 (Ceci et al., 2009) is a secondary study making use of many meta-studies, the sizes of which were not specified. It is for this reason that S87 is not included in Figure 5 .

From Figure 4 it is clear that most primary studies are performed using a population size of less than 1000. Ten studies report a population size of between 1000 and 2000, and six studies use a population size falling between 2000 and 6000 respondents. There are fewer secondary studies, but their sample sizes are ten times those of the primary studies identified in this systematic literature review.

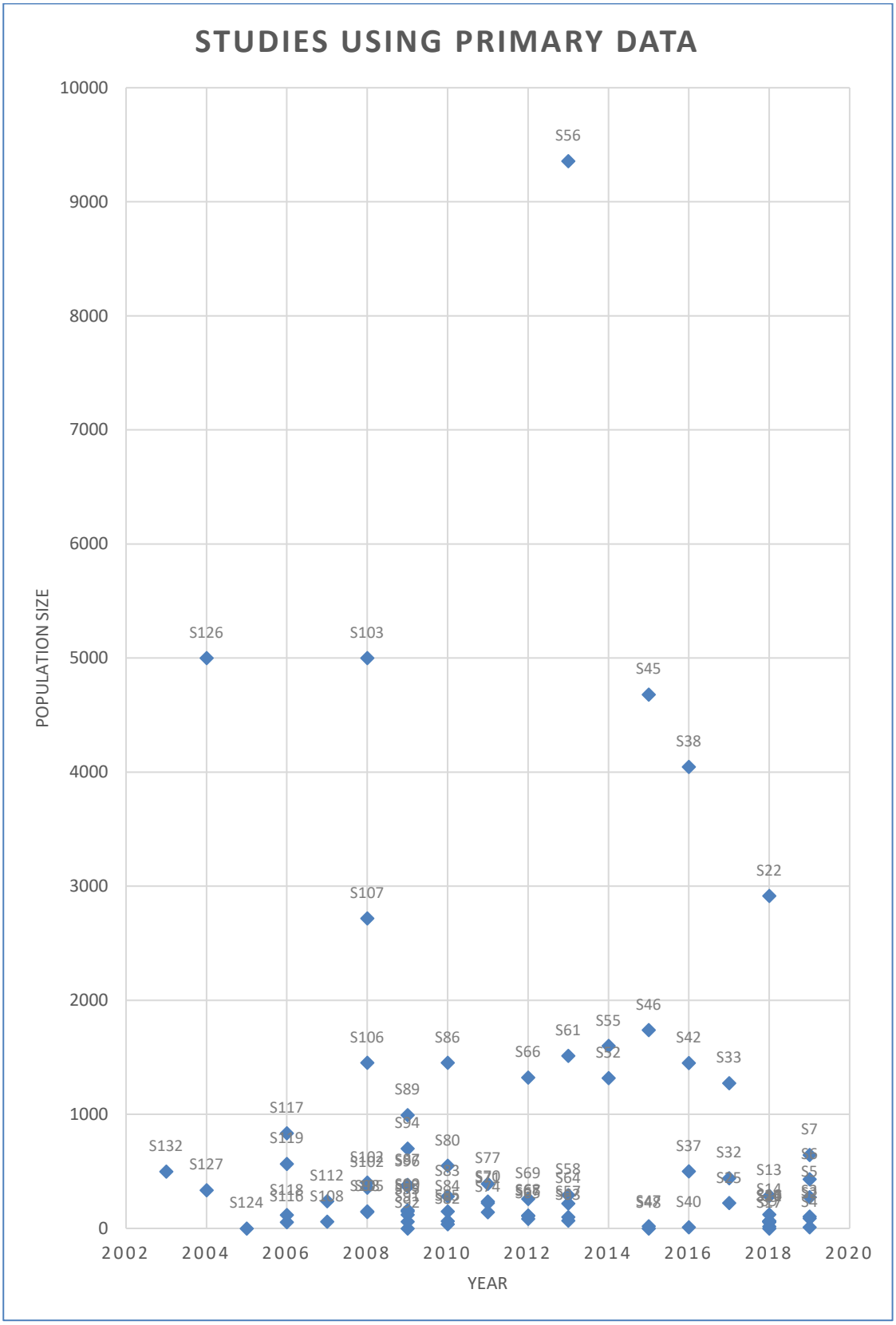


Figure 4: Primary studies on factors affecting IT major choice since the year 2000

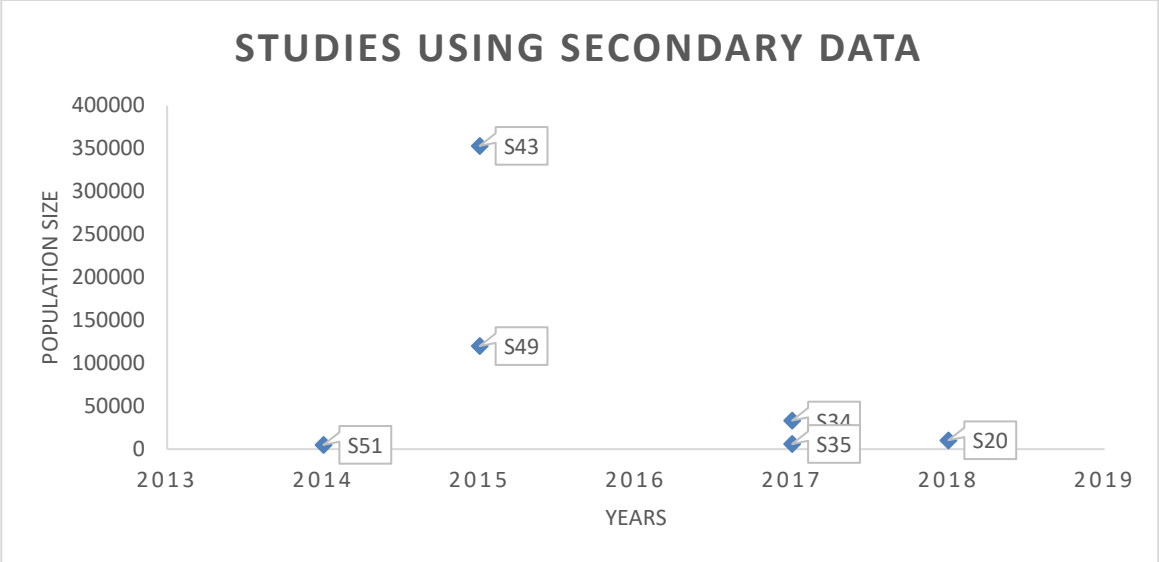


Figure 5: Secondary studies on factors affecting IT major choice since the year 2000

In addition to the studies' population sizes, their country of origin is also of interest. This is depicted in Figure 6: Studies performed worldwide since the year 2000 on the topic of factors affecting IT major choice.. The numbers in the illustration represent the papers in this literature review and they are indicated on the map according to the country of residence of their population. Four studies comprise populations resorting from more than one country.

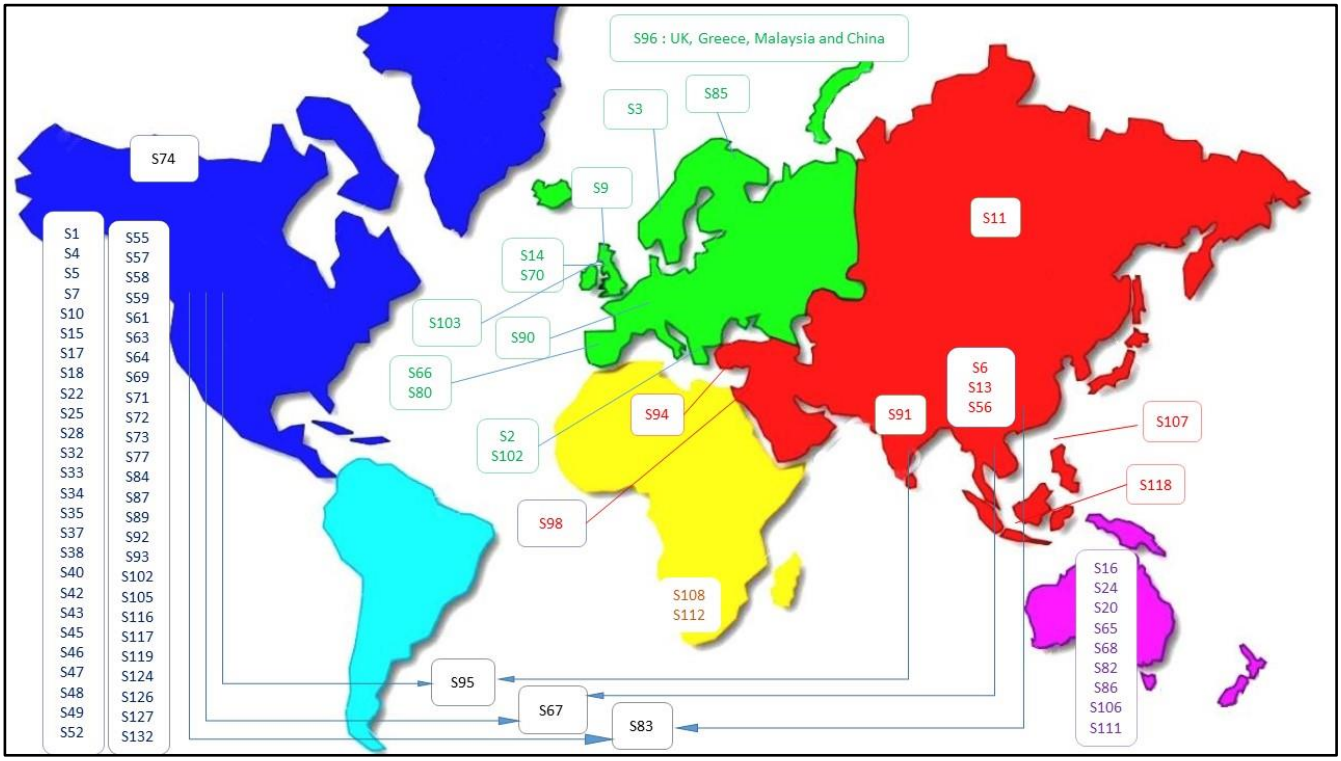


Figure 6: Studies performed worldwide since the year 2000 on the topic of factors affecting IT major choice.

Table 10: Studies according to their country of origin, population type and population size lists the studies displayed in Figure 5 according to their country of origin, population type and population size.

Table 10: Studies according to their country of origin, population type and population size

Country	Study number	Year	Population Size	Method / Participants
Australia	S16	2018	65	Teachers
	S24	2018	65	Teachers
	S20	2018	10370	Secondary school pupils
	S65	2012	85	Students
	S68	2012	113	Secondary school pupils
	S82	2010	37	Students
	S86	2010	1453	Secondary school pupils
	S106	2008	1453	Secondary school pupils
	S111	2007	0	Literature Review
Canada	S74	2011	143	Students
China	S56	2013	9356	Primary school pupils
	S6	2019	431	Primary school pupils
	S13	2018	287	Primary school pupils

Netherlands	S103	2008	5000	Primary school pupils
Finland	S85	2010	64	Secondary school pupils
Germany	S90	2009	160	Secondary school pupils
Greece	S2	2019	89	Students
Greece	S102	2008	358	Secondary school pupils
India	S91	2009	60	Students
Israel	S98	2008	146	Secondary school pupils
Malaysia	S118	2006	118	Students
Norway	S3	2019	105	Primary school pupils
Russia	S11	2018	56	Parents
Scotland	S9	2018	17	Students
South Africa	S108	2007	61	Students
	S112	2007	240	Primary and Secondary school pupils
Spain	S66	2012	1324	Secondary school pupils
	S80	2010	550	Secondary school pupils
Taiwan	S107	2008	2719	Students
Turkey	S94	2009	700	Secondary school pupils
UK	S14	2018	123	Secondary school pupils
	S70	2011	236	Students
UK, Greece, Malaysia and China	S96	2009	368	Students
USA	S4	2019	11	Students
	S7	2019	645	Secondary school pupils
	S5	2019	275	Students
	S1	2019	Not specified	Secondary school pupils
	S18	2018	Opinion piece	Students
	S10	2018	65	Secondary school pupils
	S17	2018	Not specified	Students
	S22	2018	2916	Students
	S15	2018	Opinion piece	Literature Review
	S25	2017	223	Students
	S32	2017	440	Students
	S33	2017	1273	Secondary school pupils
	S28	2017	Review	Literature Review
	S34	2017	33316	Students
	S35	2017	6038	Students
	S37	2016	502	Secondary school pupils
	S38	2016	4046	Students
	S40	2016	11	Secondary school pupils
	S42	2016	1451	Secondary school pupils
	S46	2015	1739	Secondary school pupils and Students
	S47	2015	20	Students
	S48	2015	Not specified	Students
	S45	2015	4680	Secondary school pupils and Students
	S43	2015	353000	Students
	S49	2015	119979	Students
	S52	2014	1319	Students
	S55	2014	1600	Students

	S57	2013	100	Students
	S58	2013	293	Students
	S61	2013	1513	Secondary school pupils
	S63	2013	70	Students
	S64	2013	220	Students
	S59	2013	Review	Literature Review
	S69	2012	259	Students
	S71	2011	223	Students
	S77	2011	392	Students
	S72	2011	Not specified	Secondary school pupils
	S73	2011	Review	Secondary school pupils
	S84	2010	150	Students
	S87	2009	Unspecified	Scholars, students and adults
	S89	2009	994	Secondary school pupils and Students
	S92	2009	Review	Students
	S93	2009	150	Students
	S102	2008	403	Students
	S105	2008	150	Students
	S116	2006	56	Students
	S117	2006	836	Secondary school pupils
	S119	2006	567	Workforce
	S124	2005	Unspecified	Students
	S126	2004	5000	Students
	S127	2004	335	Students
	S132	2003	500	Workforce
USA, India	S95	2009	120	Students
USA, Thailand	S67	2012	109	Students
USA, China	S83	2010	282	Students

From the table above it is clear that the United States of America publishes the most research worldwide on the topic. Regarding collaboration, only four studies have managed to publish collaboratively, being from the USA (S95, S67 and S83) and the UK (S96).

The 89 individual studies included in this literature review were listed in a matrix together with their key findings (Appendix B). This matrix was called the Theme Matrix since it formed the instrument by which the different findings of the studies were identified and summarised. Categories for grouping the different findings from the studies were drawn from Figure 2. An extra category was added for general aspects such as new methods being applied in researching the subject. Categories included phases of education and different levels of influence on an individual.

The themes from the Theme Matrix (Appendix B) are summarised and critiqued below. The findings were not statistically combined as per a quantitative review, since the studies vary greatly in method, population and findings. A qualitative review was better suited to the task.

2.8 DISCUSSION

Six categories were used to group the concepts identified in the literature regarding factors affecting the decision of female students to major in IT. They are listed below

- Personal – personal preferences, psychological variables
- Microsystem - peers, parents, teachers
- Meso system - education, industry
- Exosystem - school, social environment, infrastructures
- Macrosystem - country, technologies
- Intersectional themes

The themes are now discussed according to these categories. The review concludes with a summary of the best quality papers and the most pertinent findings across all the papers.

2.8.1 Personal aspects

The first category contains findings related to personal aspects of the individuals concerned. Mathematics self-concept, which entails a person's perceived ability in mathematics, directly influences IT major choice. Nix and Perez-Felkner (2019) investigated students' Mathematics self-concept on both gender and ethnic levels, and found that males have stronger maths self-concept than females. Various other studies confirm this (Jung et al., 2017, Kallia & Sentance, 2018, Sax et al., 2015 and Sáinz & Eccles, 2012). The same goes for computer self-efficacy, which is defined as one's perceived ability to do a specific task. Without exception, studies report that males' computer self-efficacy (CSE) is higher than females (Heinze & Hu, 2009, Beyer et al., 2004 and Almstrum & Last, 2006). It would seem logical that computer self-efficacy would improve with exposure; after all "practice makes perfect"! However, for females, the opposite seems to be true. Witherspoon et al. (2016)

shows that the gender gap in programming involvement actually widens over time – enthusiastic initial female participation in robotics competitions is not sustained. They were unable to identify the reasons and called for follow-up studies to explain the factors influencing programming involvement. Papavlasopoulou, Sharma and Giannikos (2019) confirmed that girls entertain different perspectives about coding and exhibit a different approach during coding activities than boys, yet they demonstrate the same level of competence. It shows that difference is not a weakness, on the contrary, when combined, diversity is strength.

Anxiety towards technology goes hand-in-hand with the abovementioned perceived abilities, and many studies show that females experience significantly higher computer anxiety than males (Baloğlu et al., 2009; Roli Varma, 2010 and Roli Varma, 2009b). However, Nix and Perez-Felkner (2019) also investigated inter-ethnic differences and interestingly found that despite all these insecurities, Black women were more likely to declare a mathematics-intensive major than women of other ethnicities. This indicates forces at play other than personal choice. Croasdell, McLeod and Simkin (2011) found that a “genuine interest in IS” plays an important role in a female’s decision to major in IT. This seems like an anomaly considering the role of the abovementioned insecurities, but in fact it shows yet again that there are many and sometimes conflicting influences on a female’s decision to major in IT.

Lehman et al. (2017) discovered several unique personality attributes of women who decide to make IT their career. This topic was grouped under “Intersectional themes” but fits well into the current discussion on personal aspects of women in IT. Lehman et al. (2017) discovered that women in Information Technology and Computer Science, in comparison with others of both genders, have lower high school grades, are more undecided on their career plans, rate themselves lower on academic and leadership ability but score better on artistic and language ability.

The perceived usefulness of IT manifests differently between genders. Females experience computing knowledge as external to themselves (in enhanced employment prospects) but for males it is a personal interest (Papastergiou, 2008). The perceived usefulness of IT can

therefore be enhanced by social interaction among boys, whereas girls need external encouragement (Cheng, 2019).

A person's psychological traits greatly influence choice of career. Beyer (2014) determined that students who were interested in computer science, exhibited low family orientation, low conscientiousness and low openness to experiences but scored high on computer self-efficacy. Saleem, Beaudry and Croteau (2011) identified four out of the Big-5 factors of personality as explaining computer self-efficacy (CSE) - extraversion, openness, and conscientiousness while low on agreeableness. They also found personality differences between men and women regarding personality factors that influence CSE. Women who scored higher on neuroticism and extraversion and lower on agreeableness, scored higher on CSE.

2.8.2 Microsystem – peers, parents, teachers

The second category of factors affecting the decision of female students to major in IT are the people who exert a direct influence on the individual – their parents, their peers and their teachers. Two of the aspects in this category fall among the top three most pertinent factors, as identified by most of the papers in this literature review. They are the importance of parental encouragement and the overall lack of knowledge regarding available IT careers. These two aspects are discussed below, under the heading Pertinent Findings.

Three studies highlight the salience of parents as being the primary influencers. Mahatanankoon, Watanapa and Sathapornvajana (2012) report that in Thailand, parents hold a high level of authority and exert significant influence over a young female's career choice. Miles (2009) explains that immediate family is most supportive of the young student's interests and therefore plays a critical role in career choice. In the same vein, Meszaros, Creamer and Lee (2009) report that parental guidance override the advice of trusted others in a young female's career choice. With this in mind, they stress the need for better parental education in the opportunities offered by the IT industry. Mitra (2016) adds to the importance of parent education by adding that they need to see that coding is not "difficult or boring", so

that they are able to understand the nature of IT and be willing to support their children in pursuing their interests.

Peers are an important source of information on life choices, including career choices (Riegle-Crumb & Morton, 2017) and could instil confidence and signal belonging in a perceived male-dominated field.

Yang et al. (2013) found that primary school level computer experience benefits all students regardless of demographics. In the scramble to attain computer literacy, significant amounts of time and money are invested in primary and secondary schools worldwide. While computers form part of modern life, many believe that school-level computer experience is a necessary pre-requisite for tertiary level computer studies. This has however been disproved repeatedly (Google, 2014). Alshahrani, Ross and Wood (2018) finds that school level computer education has less influence than exposure to problem solving and online self-learning.

2.8.3 Meso system- education, industry

The third category of factors affecting the decision of female students to major in IT pertain to industry and education. The school subject Mathematics offers the greatest potential for getting girls into IT. Mathematics attracts many women, and bridges could be built by offering interdisciplinary degrees (Law, 2018; Clark and Ivankova, 2018; Clarke et al., 2018).

With regards to computer education at school level, Tien and Fu (2008) found that there are certain students that are at a disadvantage in terms of computer skills and knowledge. These are usually children of blue-collar workers or unemployed parents. Nevertheless, they found that students learn best when working on a variety of software applications at school, and that it is the best way to learn more about computing.

An added benefit of gaining computer experience at school is elevated confidence levels, a critical factor in female IT study choice (Dubow and James-Hawkins, 2016, Meelissen and Drent, 2008), especially taking into account that most schoolgirls exhibit no interest at all in

computers (Anderson et al., 2008, Lang, 2007). Banerjee and Maria (2013) report that male students are interested in the school computer courses but that females only took the course if it was prescribed – in other words, that they had no other choice. This negative attitude is possibly due to the fact that school computing classes are boring, consisting of meaningless tasks presented by unwilling, uninformed teachers (Roli Varma, 2009b; Lasen, 2010).

Being truly interested in a subject means a person is prepared to spend leisure time on it. This is the case for male students who often have work experience gained (Varma and Hahn, 2008), a distinct advantage over female students, who are often undecided in their final school year as to the career they would choose to follow. On the bright side, this situation is an opportunity to inform students of the opportunities that await them in the IT industry (von Hellens et al., 2017).

Industry itself presents many problems that young females take into consideration when making a career choice. The IT industry is widely known for its male hegemony (Bernstein, 2018) exuding a chilly climate to all perceived outsiders (L. K. Morris & Daniel, 2008). This is more than a stereotype, and affects different minorities in different ways, all negative. When females (and other minorities) are able to surmount this obstacle, they are confronted with further negatives such as lack of potential IT job satisfaction (Miles, 2009) and the myriad of work-life balance issues that are not currently addressed by employers (Georgiadou et al., 2009).

2.8.4 Exosystem - school, social environment, infrastructures

The fourth category of factors affecting the decision of female students to major in IT include the social environment and societal infrastructures. Michell et al. (2018) describes the societal influences according to which this qualitative review is structured. In the innermost layer, the young person's CS interest is influenced by the people closest to him, who sit in a wider community which in turn is influenced by various infrastructures and values around the concept of gender and IT of the country in question.

Students are influenced by a great variety of societal aspects. These include stereotypes created by society and the media which, in turn, influence perceptions of the IT environment and of the people working there. A prevalent social norm is that a person has to be smart to work in IT (Jung et al., 2017). This is a stereotype and should be called out as such. Trauth et al. (2016) comments on the widespread masculine stereotyping of technical IT skills and shows that within-gender variation in gender stereotypes of IT exists and results from inconsistent gender stereotypes being applied to those IT skills seen as nontechnical. Due to the general stereotypes of a computer programmer as lacking in people skills (Cheryan et al., 2013), females are of the opinion that CS is a career better suited to men (Bock, 2013). Females who are genuinely interested in computing as a career, are also concerned with the image they will be projecting to society once they declare their major. Cheryan et al. (2019) calls it a double identity threat, which makes taking such a step doubly daunting for women.

Paradoxically to all the barriers described so far, certain aspects of the social infrastructure work in ways to enable women entry into IT. One is the fact that there are many ways a woman can enter the IT field. As mentioned earlier, computer training at school (or the lack of it) has a surprisingly small effect on the eventual decision to major in CS. It is not necessary to start at a very young age to get into IT (Collain, 2018). The fact that a job in IT invariably means job security and a good income, makes it attractive to many women (Almstrum & Last, 2006).

2.8.5 Macrosystem - Country, technologies

The fifth category of factors affecting the decision of female students to major in IT include overarching factors such as the role of government and the global technology industry.

The role of government in diversifying the IT workforce is first and foremost educational. It is essential to improve the quality of computer science education, especially at the secondary level which is the time in life where most young people make their career choices (A. Lee, 2015). Another responsibility of government is to ensure funding to allow individuals to qualify themselves in the field, especially those who cannot afford to carry the burden of

the cost themselves, particularly those from underrepresented racial and ethnic minorities (Crutchfield et al., 2011). Underrepresented minorities usually lack the necessary social networks to inform them of the possibilities in the IT field, and they are consequently unaware that they could pursue a career in IT (Fuller et al., 2015, Cain & Trauth, 2015).

The global ubiquity of technology has convinced everyone that it is here to stay, and that more importantly we need a suitably qualified workforce to make it work for us. Despite the negative connotations, computing is increasingly being seen as an attractive career offering good employment possibilities (Clarke et al., 2018). Girls are still intimidated by the need for mathematics and physics skills and therefore it is necessary to educate and inform students of the variety of IT jobs available, each of which require different competencies (Leiviskä and Siponen, 2010).

2.8.6 Intersectional themes

In the last 5 decades of gender and IT research, the focus has slowly moved from purely gender essentialist studies towards studies that take into account more variables than a simple male/female dichotomy. This refinement has been necessary to allow a finer-grained picture to emerge. Lord et al. (2015) explicitly call for intersectional approaches that disaggregate findings by both gender and ethnicity.

One of the avenues of intersectional gender and IT research seen here, is the findings from inter-country and therefore inter-cultural research. Varma (2009a) and Varma (2009c) conducted a study with 60 CS undergraduate females of different ethnicities from both USA and India, and found that the Indian females were more confident in the IT environment due to their strong mathematical background and the fact that they saw the field as being woman-friendly. Othman and Latih (2006) found the same in Malaysia, where they report gender equality in IT among young Malaysians and no lack of female role models. In addition to this, the females match or outperform the males in CS despite the males having considerably more experience. It clearly shows that there is no match between prior experience and course grades. Another avenue of study is illustrated in Eidelman and Hassan (2008) and Marsh (2007) who investigate inter-country intra-cultural aspects. Eidelman et al. (2008)

finds that young Arab females are more likely to choose IT than young Jewish females, and Marsh (2007) finds that young Black African females are more likely to choose IT than young White females. They both postulate that it is due to the former groups being from economically disadvantaged groups and see IT as a way to improve their situation. Sáinz and Eccles (2012) investigates a population of Thai female students and conclude that their success in IT studies stems from the fact that they belong to a collective society where they attribute their successes to external factors.

2.8.7 High quality studies

Among the 89 identified papers in this review lie a number of high quality research papers. Ceci, Williams and Barnett (2009) used over 400 studies from various disciplines such as psychology, education, sociology, anthropology, neuroscience and economics to develop a framework of possible causal pathways to individuals majoring in maths-intensive careers. The importance of each factor was evaluated and the strength of its effect indicated in the framework. They found that maths-proficient women are both more likely to leave maths-intensive careers as they advance, or to choose other professions due to their concomitant high verbal competence. However they found that the most powerful explanatory factor is their individual preferences, followed by performance on gatekeeper tests. They conclude that the most powerful influencers are sociocultural and not biological causes.

The United States' National Center for Women & Information Technology published a report in 2012 (Ashcraft et al., 2012) describing the state of affairs for girls in computing, identifying the main barriers to girls' participation in computing fields, and practices for addressing these barriers. In 2014, Google (2014) contracted a research firm to conduct a study on a diverse population of college-going Americans: 1000 women and 600 men of diverse academic and geographic backgrounds. They found that controllable (and actionable) factors such as exposure and encouragement play the largest role in young females' choice of IT majors. Wang et al. (2015) conducted a study on 1090 female and 649 male high school and college students pursuing CS and found that exposure and encouragement critically influence the major choice for women. Trauth (2016) used the Individual Differences Theory of Gender and IT to investigate the stereotypes held about IT skills by 4046 U.S. university students.

They found not only inter-gender differences but also inter-ethnic variation in how these stereotypes are understood. Cheryan et al. (2016) performed a review of relevant literature to answer the important question of why women are overrepresented in some STEM fields but critically underrepresented in others. They identified three factors barring women: an unwelcoming, masculine culture in engineering and computer sciences, lack of sufficient experience in the field, and a much lower level of self-sufficiency on the part of the women. Potvin et al. (2018) investigated the same phenomenon and found that female students are less interested in electrical and computer engineering than in biomedical engineering since the latter is associated with helping others and the former is not. Another explanation for the lack of female interest in computer-related majors, is identity expression threat, which is the concern about conveying an identity that clashes with one's gender role. Cheryan et al. (2019) finds that women considering an IT major, experience a double identity threat, in other words they fear being isolated by both sides: those within the CS field as well as those outside.

2.8.8 Contradictions

Among the findings enumerated above, there were two that were contradictory. The first regarded the value of school computer training. Bovée et al. (2007) found that pre-college experience with computers was crucial, while Collain (2018) found that it made little difference to eventual choice of CS major. This dissonance might be put into perspective when the findings of Tien and Fu (2008) are also taken into consideration. Their population consisted mainly of primary school children from disadvantaged backgrounds, who were not exposed to computing technology and therefore had little experience of its utility. They found that limited exposure to computing did not influence college students' academic performance or choice of major as much as their individual devotion to academic work. Indeed, they found that students who had less educated mothers, spent a higher proportion of their computer hours on academic-related work. This indicates goal-driven behaviour among students from lower socio-economic strata.

The second contradictory finding pertains to the perceived status of the IT discipline. Reports abound of the IT discipline suffering from lower status than other disciplines (Sáinz & Eccles,

2012, Mahatanankoon et al., 2012) and blame the lack of status for parents advising their children against IT careers. The opposite is reported by Leiviskä and Siponen (2010), that the IT field is a respected profession that can ensure good employment possibilities.

2.8.9 Pertinent Findings

The most pertinent findings across all the papers in this literature review, are easily identified by a glance at the Theme Matrix (Appendix H). Most themes appear in two or three papers but three themes stand out as appearing in 10 or more papers. The first of these is the fact that participation in the IT workforce is constrained by lack of awareness thereof. Parents, prospective students and school teachers are simply not aware of the types of jobs that are available in the IT field. Neither do they know what route a candidate should follow to get there. A great number and diversity of initiatives in various countries have attempted to educate the public about the opportunities that exist, but with limited effectiveness. Swaying public opinion is no easy task, be it in revealing stereotypes for the phantoms they are, or be it convincing parents that there awaits a prosperous future for their offspring in careers other than the traditionally prestigious Law and Medicine. The second of the top three themes identified in this study is subject preference. Males are more attracted to mathematics and technology while females prefer the humanities. This is more than just a stereotype; literature shows that even in a scenario where technology is equally accessible to all, males engage with technology itself whereas females use technology as a means to an end – an end usually in the humanities. The third most important theme in factors that influence female IT career choice, is shown to be the importance and effectiveness of parent and teacher encouragement. Seeing that females exhibit lower confidence in their abilities than males, together with the fact that they attach greater weight to the opinions of their superiors, it comes as no surprise that a little bit of encouragement by a well-informed parent or teacher, goes a long way. It is encouraging that this factor is completely controllable, and that simply informing stakeholders of the fact, could affect a big improvement.

2.9 LIMITATIONS

This systematic literature review was limited in three important aspects, due to the fact that it was performed as literature review for a thesis, and therefore the work of only one author. The first limitation was the absence of any independent reviewers. The accepted norm for a systematic literature review is the rigour afforded by one or more researchers reviewing the literature, in some cases using a scoring system to rate the content of the publications. This review lacks the benefit of a second opinion.

The second limitation pertains to the fact that an insufficient number of articles were identified via the “hand search” phase of the systematic literature review. Quality studies such as Teague (2000) and Barker and Aspray (2013) come to mind, respectively being referenced by Alshahrani, Ross and Wood (2018) and Lasen (2010) in this review. The reason for not including such studies is simply to limit the scope of an already large body of included literature. Completing the hand search according to the underlying search protocol can form a fruitful future study.

The third limitation of this systematic literature review is the absence of any unpublished articles due to the fact that their results did not support their research hypotheses. Due to time constraints the author did not attempt to locate such literature.

2.10 CONCLUSION

In conclusion it can be said that IT practitioners need to accept that the low numbers of women in IT is not only a “woman’s issue” and that the dominant gender needs to practically address the situation (Lang, 2007). Guthrie, Yakura and Soe (2011) identify two problems that can be effectively addressed: firstly building alliances between disciplines that have been proven to interest women, and secondly to define career paths in IT in a way that is understandable to pre-college students.

Clarke et al. (2018) conclude that development within the IT field leads to more interdisciplinary work, which leads to a more diverse population of IT workers, leading to a

broader recognition of the demand for diverse computing skills. Bernstein (2018) believes that change will come from within IT companies, and not via legislation or the government. Already prospective employees have moved from asking “how fun is it to work at your startup?” to “what’s your commitment to …. creating a culture where respect and transparency are fundamental?”. Bernstein (2018) concludes with saying that diversity and transparency in IT hiring is improving, but that it will need constant work.

3 THEORETICAL PERSPECTIVE

3.1 INTRODUCTION

This chapter describes the hunt for the theoretical underpinning of this study. It provides a background on the current theorising in the field of gender and information technology, and then describes how a gender-and-IT theory was identified to inform data gathering and interpretation throughout this study. The second part of the chapter describes a sociological theory which was harnessed to interpret the findings of the study.

3.2 IDENTIFYING A THEORY TO INFORM DATA COLLECTION

Theories in the field of gender and IT research mostly originate from the social sciences. Researchers in this field have employed various theoretical frameworks in attempting to understand the situation of women in the IT environment, and to record the knowledge gained from their research. Despite a large body of research, criticisms are still being levelled at the perceived insufficient theorising of gender in information systems (IS) research.

Gallivan (2013) reviewed 190 papers on gender and IS from a selection of IS journals and conferences since the early 1990s. He found that not only do a minority of papers explicitly employ a gender theory, but that the issue of gender only arises when women are added to the study. This implies that most authors assume that males are the norm in the IS field, an assumption that he says should be challenged. He concludes by highlighting the need for authors to explicitly articulate the gender theory they use in their studies, regardless of the popularity, or otherwise, of the said theory. Another study that was published in the same year, takes the theorising issue firmly in hand by performing a critical literature analysis on the topic of gender and information systems theorising. Trauth (2013) identified 132 journal articles on the topic of gender and information systems theorising that appeared in leading IS journals in the 20-year period from 1992 to 2012. She analysed each in terms of focus and approach to gender theory, and concludes that there is a sufficient body of gender and

IS research to warrant moving away from descriptive studies toward analytical and theoretically informed studies.

The aim of this chapter is to identify a suitable theory to inform data gathering for this study. This is done by using Trauth's paper (2013) as a baseline, updating it and analysing the collection of theories to see which would best suit the current study.

3.2.1 Identify publications on gender and IS theories

Trauth's (2013) list of publications on gender and IS theorising in IS research formed the departure point for identifying a suitable theory to use in this study. Since the list contains publications up to the year 2012, it needed updating to reflect current studies. All publications were then examined in order to identify the most suitable contemporary theory to use for the current study. Figure 7: Process followed to identify a suitable gender-and-IT theory illustrates the process that was followed.

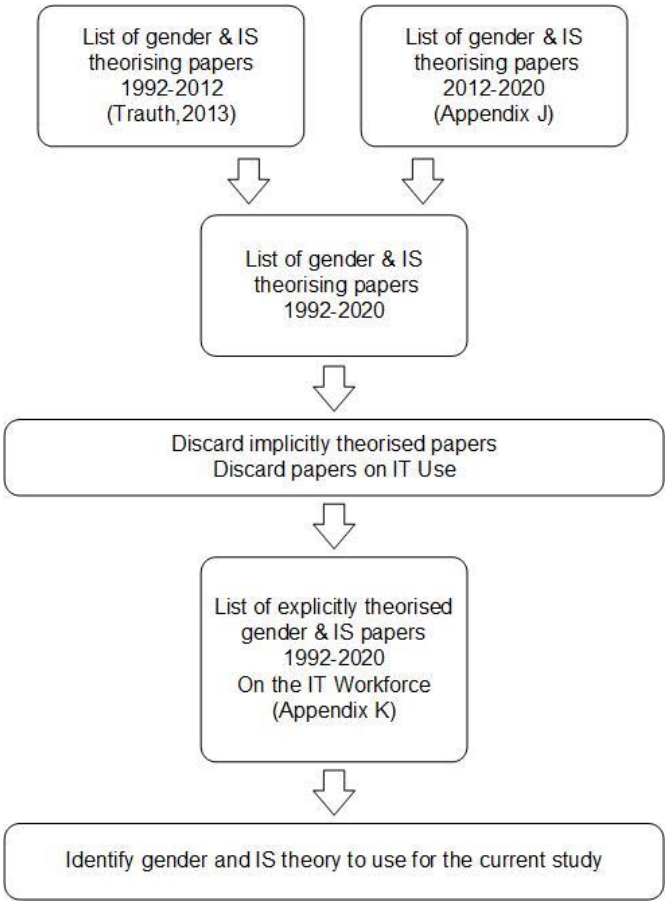


Figure 7: Process followed to identify a suitable gender-and-IT theory

In order to update the list, the researcher examined the same journals for papers on gender and IS by searching for the word “gender” or an equivalent such as “female” or “women” in the title, abstract or keywords, but this time for publications newer than 2012. Some 44 journal papers were identified (See Table 11).

Table 11: Journal papers (by journal name) on gender and IS that were published between 2012 and 2020.

Journal	Authors
The Database for Advances in Information Systems	Brooks, Hardgrave, O’Leary-Kelly, McKinney & Wilson, 2015 Ge, Kankanhalli & Huang, 2015 LeRouge, Wiley & Maertz, 2013 Trauth, Cain, Joshi & Kvasny, 2016
European Journal of Information Systems	Chen & Sharma, 2015 Foth, 2016 Gorbacheva *et al.*, 2019
Information and Management	Lin, Featherman & Sarker, 2017

	Zhang, Zhao, Lu & Yang, 2016
Information and Organization	Trauth, 2013
International Journal of Technology and Human Interaction	Chiu, 2012 Park, Lee & Shin, 2015 Khedhaouria & Beldi, 2014 Nisha, Iqbal, Rifat & Idrish, 2017 Reid & Thomas, 2017 Smith, Mendez & White, 2014
Information Resources Management Journal	-
Information Systems Journal	Annabi and Lebovitz, 2018 Armstrong, Riemenschneider and Giddens, 2018 Craig, 2016 Newman, Browne-Yung, Raghavendra, Wood & Grace, 2017 Pozzebon, Mackrell & Nielsen, 2014 Venkatesh, Sykes & Venkatraman, 2014 Windeler & Riemenschneider, 2015 Xu, Xu & Li, 2015
Information Systems Research	-
Information Technology and People	Alam & Imran, 2015 Dhar-bhattacharjee and Richardson, 2018 Huang, Shi, Chen & Chow, 2016 Mishra, Ostrovska & Hacaloglu, 2017 Molnar & Hava Muntean, 2015 Newbery, Lean & Moizer, 2016 Wijayawardena, Wijewardena & Samaratunge, 2016
Journal of the Association for Information Systems	Fehrenbacher, 2017 Gallivan & Ahuja, 2015 Hansen & Walden, 2013
Journal of Information Communication and Ethics in Society	Baglione, Harcar & Spillan, 2017 Flick, 2015 Fothergill *et al.*, 2019 Khalil & Seleim, 2012 Yeganehfar *et al.*, 2018
Journal of Information Technology	Laumer, Maier, Eckhardt & Weitzel, 2016
Journal of MIS	-
Journal of Strategic Information Systems Table 11	Krasnova, Veltri, Eling & Buxmann, 2017
MIS Quarterly	Oreglia & Srinivasan, 2016 Godinho de Matos, Ferreira & Krackhardt, 2014 Venkatesh, Windeler, Bartol & Williamson, 2017

The 37 papers from Table 11: Journal papers (by journal name) on gender and IS that were published between 2012 and 2020. (but presented in the same way as the list of 132 papers in

Trauth (2013)) can be seen in Appendix J. This set of papers contains 12 papers on the IS workforce, six of which explicitly use a gender theory and six more which are gender atheoretical.

The six explicitly theorised papers were then merged with those papers from Trauth's (2013) study which also explicitly use a gender theory and focus on the IS workforce. Together, these studies represent the last 25 years' peer-reviewed IS journal papers on gender and IS theorising of the IT workforce (see Appendix K).

Figure 8 plots these papers graphically on a timeline. Each paper is identified as using either a gender theory or a gender and IS theory (written in italics). The papers in boldface include a theory that resulted from the study. Arrows indicate theories that were used in subsequent studies.

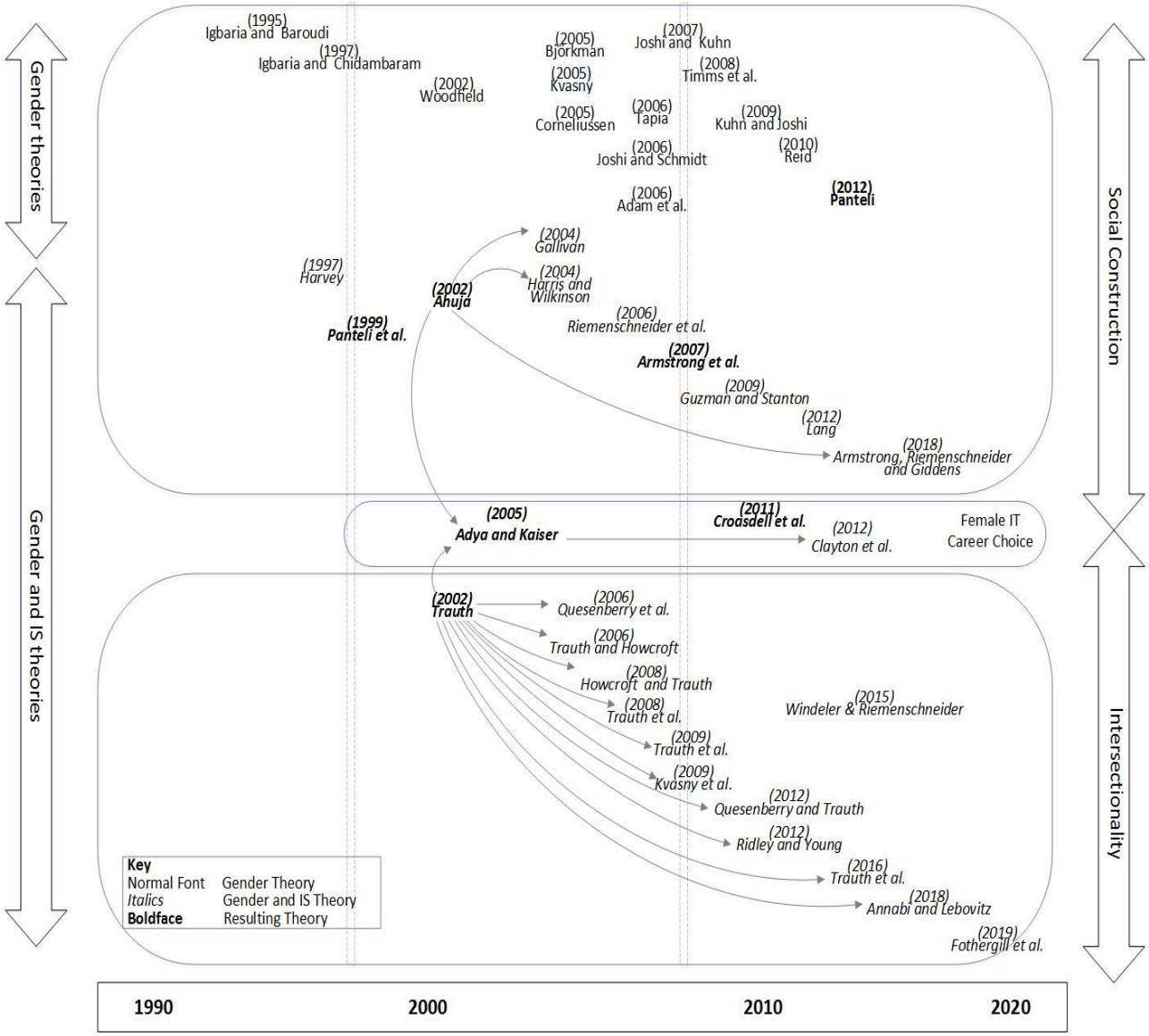


Figure 8: Chronology of papers that theorise gender and the IT workforce: 1992–2020

The papers depicted in Figure 8 were arranged according to the types of theories used – starting with gender theories along the top and moving down to gender and IS theories. The studies themselves are now discussed.

3.2.1.1 Papers that use gender theories

Table 12 contains the papers that were identified as using a gender theory to investigate aspects of the gender imbalance in the IS field. Four of the papers use feminism as a theoretical lens and the others use the lens of social construction.

Table 12: IS workforce studies using gender theories.

Author	Finding
Igbaria & Baroudi, 1995	No significant gender differences in job performance ratings, but men get more chances for promotion than women. Significant gender differences observed in tenure, human capital and seniority.
Igbaria & Chidambaram, 1997	Gender differences cannot be explained by work experience and tenure alone.
Woodfield, 2002	Due to the first two decades of the computing industry being populated by males, the culture is insular and esoteric. Male workers and their competencies are privileged. The nature of IS work will not automatically shift when more women undertake it.
Björkman, 2005	Feminist research in technology and computing.
Kvasny, Greenhill & Trauth, 2005	Implications of conducting feminist projects in management information systems (MIS) research.
Corneliussen, 2005	Many women take pleasure in computing, master the technology, and gain status in computing as a masculine field.
Tapia, 2006	Despite an acute shortage of employees, the businesses protected their homogenous organisational culture and sustained a hostile work environment against female employees.
Joshi & Schmidt, 2006	Computer science and IT stereotypes disappear when students are educated in the unique nature of IT. But the general perception of an IS professional favours masculine traits and abilities.
Adam, Griffiths, Keogh, Moore, Richardson & Tattersall, 2006	Women's experience embedded in socio-cultural contexts. Organisational culture is not changing.
Joshi & Kuhn, 2007	A "top performer" in IT exhibits a variety of skills and is seen as somewhat masculine.
Timms, Lankshear & Anderson, 2008	Aspects of the work environment, culture and expectations that contribute to women's comfortable fit, or otherwise, in the IS industry. Female discomfort in the ICT industry is not an industry-wide phenomenon, but it originates in particular workplace relationships.
Kuhn & Joshi, 2009	Male and female aspiring IT professionals agree on the same work values and job attributes, yet place subtle differences on these factors.
Reid, Allen, Armstrong & Riemenschneider, 2010	Male participants have a superficial understanding of the challenges that women encounter in their workplaces and in the IS field. Men and women have little cognitive overlap with regard to the challenges that women face.
Panteli, 2012	Women have less human capital (training and education) due to their interrupted pattern of employment, and therefore fewer choices in the workplace.

All the studies in this group of papers investigate gender issues in the IT workforce. Without exception the studies found that the IT profession is perceived as masculine. Joshi and Schmidt (2006) found that even though stereotypes disappear when people realise the unique nature of IT, the IT professional is still perceived as masculine. Due to the computing industry being male-dominated, the industry is insular (Woodfield, 2002) and males get

promoted faster (Igbaria & Baroudi, 1995). Women have less human capital due to interrupted employment (Panteli, 2012)(N. Panteli, 2012). The industry culture is hostile to women (Tapia, 2006) and males have little understanding of the challenges that women face (Reid, Allen, Armstrong & Riemenschneider (2010). Adam *et al*. (2006) posit that the organisational culture is not set to change.

Woodfield and Joshi (2009) found that males and females agree on the same work values yet place subtle differences thereon. Viewed retrospectively, these studies might have been more successfully completed using an intersectional approach.

3.2.1.2 Papers that use gender and IS theories

Table 13 contains all the papers identified as using a gender and IS theory to investigate aspects of the gender imbalance in the IS field. About half of the papers use the lens of social construction while the other half (notably the most recent half) use intersectionality as their theoretical lens.

Table 13: IS workforce studies using gender and IS theories – contributions to understanding and intervention.

Author	Finding
Harvey, 1997	This paper describes four formative cultures that have influenced the IT culture: the military, academia, engineering and industry. It is posited that the IT culture, which is socially constructed, is a masculine culture that denies the feminine voice.
Panteli et al., 1999	The low proportion of women and their under-representation at the higher ranks of both the technical and management career paths. Even though the IT industry does not exclude women, it does little to promote them or even to retain them in the field.
Ahuja, 2002	Three career stages (entry, persistence and advancement) that limit women's career progress. These factors translate to fewer women higher up in the IT industry hierarchy.
Gallivan, 2004	Investigates IT professionals' ability to adapt to a changing work environment. Women enacted different patterns of job performance and skills than men. The women showed weaker technical skills than the men, but stronger communication skills.
Harris & Wilkinson, 2004	The perceived presence of women in any occupation served as a negative indicator of its perceived status, salary and required qualifications. Many

Author	Finding
	women are choosing to absent themselves from information occupations that require in-depth computing knowledge.
Riemenschneider, Armstrong, Allen & Reid, 2006	Workplace barriers to women in IT and factors that influence their turnover.
Armstrong, Riemenschneider, Allen & Reid, 2007	Four major concepts, namely managing family responsibilities, work stress, work schedule flexibility and job qualities, play a role in women's work-family conflict. Women indicated that work responsibilities caused stress, not family responsibilities.
Guzman & Stanton, 2009	Women and ethnic minorities experience greater difficulty fitting into the IT culture and that it therefore directly predicts both occupational and affective commitment.
Lang, 2012	Parents remain the primary influencers to student career and course choices. The lack of women in IT is not necessarily a gender issue, but an issue embedded in the image of the IT discipline, an image of lower status than most other professional careers.
Armstrong, Riemenschneider and Giddens, 2018	The perceptions of the structural and social factors affecting women's advancement and persistence in IT careers have changed over time. Extends Ahuja's (2002) theoretical model.
Adya & Kaiser, 2005	Three factors influence IT career choice: social, structural and individual differences, with an overarching influence of culture. Parents (and not educators) influence girls' career direction, that same-sex education reduces girls' bias against IT and that early access to computing reduces intimidation.
Croasdell, McLeod & Simkin, 2011	A "genuine interest in IS" and the "influence of family" account most for a woman's decision to major in information systems, also such matters as "job-related factors" or the "influence of fellow students or friends".
Clayton, Beekhuizen & Nielsen, 2012	Presents a conceptualisation of the influence of middle-school experiences on girls' ICT study and career choices
Trauth, 2002	A qualitative study of social and cultural influences on the working lives of female IT professionals.
Quesenberry, Trauth & Morgan, 2006	Show the range of ways in which women's IT career decisions are influenced by work and family considerations.
Trauth & Howcroft, 2006	Highlight the role of power dynamics in understanding women's experiences in the IT workforce. Help to shift the focus away from essentialist theories and toward a recognition of the diversity among women in the IT workforce.
Trauth, Quesenberry, Huang & McKnight, 2008	Findings are that socio-cultural factors both bar and facilitate women's entry into and progress in the IT industry.
Howcroft & Trauth, 2008	Critical studies in gender and IS research are beneficial due to the possibilities of generating new insights since the conduct of the research changes when the epistemology shifts (e.g. from positivist to interpretive to critical).
Trauth, Quesenberry & Huang, 2009	Examine variation in organisational influences on the subjects of the study. Three factors (work-life balance, organisational climate and mentoring) affect each woman's career development in different ways.
Kvasny, Trauth & Morgan, 2009	Compare the experiences of women of colour to those of their White female colleagues. The results provide a better understanding of social exclusion and emancipatory practices.

Author	Finding
Quesenberry & Trauth, 2012	The effects of career interventions and how they consider within-gender variation.
Ridley & Young, 2012	Theoretical approaches shape people's understanding of an issue such as the under-representation of women in the IT workforce.
Windeler & Riemenschneider, 2015 Gender (minority) theory	Focus more attention on historically underrepresented groups. Leader support influenced organisational commitment for ethnic minorities, while career mentoring influenced organizational commitment for majorities.
Trauth, Cain, Joshi & Kvasny, 2016	Gender stereotypes exist, but are not uniform across all members of a gender group.
Annabi and Lebovitz, 2018	Intervention characteristics and barriers IT women experience and the coping methods they use to address barriers.
Fothergill et al., 2019	This study examined the complex, culturally contingent space around gender and increasing diversity in ICT. It finds problematic understandings of sex, gender and diversity in an ICT project case study. It warns that existing approaches that fail to acknowledge systemic inequalities and biases, and ignore the importance of intersectionality, may cause further entrenchment of current disparities in the ICT sector.

The papers using social construction theories, identified similar aspects as those mentioned in the previous section. Harvey (1997) explains that the IT occupational culture is considered masculine since it started within the military, engineering and academic fields. Guzman and Stanton (2009) show that the IT culture repels women and ethnic minorities. Panteli et al. (1999) report that even though the IT industry does not overtly exclude women, it is not pro-active in retaining them. Work-life balance remains a challenge and a concern for women (Riemenschneider et al. (2006); Armstrong et al. (2007). Both Lang (2012) and Harris and Wilkinson (2004) report on the IT field's image as being lower in status than most other professional careers. Lang (2012) confirms that parents are the primary influencers of their children's career choices.

Ahuja (2002) created the Model of barriers to women in IT that defines three stages that limit a woman's career progress and prevents them from moving higher in the IT industry hierarchy. Gallivan (2004) uses Ahuja's model to investigate an IT worker's ability to adapt. He found unique variations between his respondents. Armstrong, Riemenschneider and Giddens (2018) extended Ahuja's model to promote the creation of an occupational culture where women and minorities might flourish. They conclude that during the 16 years that had passed since Ahuja had published her theory, the gender imbalance issue has grown into a quest for diversity and an inclusive culture.

Clayton, Beekhuizen and Nielsen (2012) built upon Adya and Kaiser's (2005) model to conceptualise middle-school girls' experiences on their IT career choices. Croasdell, McLeod and Simkin (2011) encourages IS faculty to do more to attract and retain females.

In 2002 Trauth published the framework of Individual Differences of Gender and IT (the IDT) that characterises a variety of influences on a person's IT career. It is the first published paper in our list that overtly rejects the essentialist view of women in the IT profession and argues for the consideration of societal and structural influences on the individual. The next 11 papers in our list made use of the IDT as a theoretical lens to investigate a variety of issues such as socio-cultural factors that influence a person's participation in the IT field, differential stereotypes, interventions to retain minorities, and proposed media interventions to increase awareness. The last paper in the list is a gender intersectional study which calls for raising awareness of the gender issue and presenting opportunities to reflect on potential solutions (Fothergill et al., 2019).

Employing a theory should allow a better understanding of the problem under investigation, and ideally allow the identification of practical interventions. In this group of papers, only three studies had omitted making any suggestions for practical interventions, two of which were conceptual papers promoting critical research for the expected insights it could generate. All the other papers managed to suggest interventions to address the problems identified in the study.

3.2.2 Progression in gender and IS theorising

At the time that Ahuja (2002) and Trauth's (2002) intersectionality theories were published, a worldwide IT skills shortage was in evidence. Almost two decades later, the skills shortage is still dire, but research into the phenomenon has evolved. From viewing gender issues as being "males versus females", there is a wider theoretical approach to the gender imbalance - it has evolved into seeking an understanding of a diversity imbalance, with not only females recognised as being underrepresented but also other minorities such as people of different cultures and ethnicities. Various stereotypes in society are being neutralised by presenting

alternative images (Master et al., 2016) thereby reducing feelings of incompatibility. Socially, the male-female gender dichotomy is being challenged and so too are other aspects of the socio-economic landscape. Such diversity can be studied using the intersectionality theories, allowing the researcher to record every individual's response to influences from the environment.

The value of using explicitly specified theories, lies in the fact that the findings can be shared (Trauth, 2013). A body of research such as the studies discussed in this chapter, strengthens the hand of a researcher who aims to analyse, explain or address a perceived problem in gender and IS research. If the relevance of a theory is to be judged on its potential to aid in understanding a phenomenon, and subsequently in identifying practical interventions to solve the problem, the intersectional approach has been shown to effectively address issues in the diverse modern workforce, in enabling both theoretically informed research and theoretically informed interventions.

3.2.3 Theory selection for data collection

Table 14**: Individual difference factors merged with study choice factors** illustrates the creation and subsequent use of Trauth's (2002) theory of individual differences. Where the theories created in studies such as Ahuja (2002) and Adya and Kaiser (2005) are used in two or three further papers, Trauth's theory was used in at least nine further papers. Most of these studies investigated women in the workforce, but the theory was also successfully used to investigate women's career choice in information technology. It is for these reasons that the IDT was identified as a suitable foundation for the current study.

The three papers listed in the area identified as "Female IT Career Choice" in Figure 8: Chronology of papers that theorise gender and the IT workforce: 1992–2020, use gender and IT theories to investigate factors that influence female students' choice of IT majors. Croasdell, et al. (2011) use the Theory of Reasoned Action applied to gender for IS study choice while Clayton (2007) created the Model of girls' ICT study and career choices by using Adya and Kaiser's (2005) model to study the effect of the experiences of middle-school

girls on their IT career choices. The constructs used in these theories are added to those of the IDT to ensure that all previously identified aspects of study choice are included.

3.3 SYNTHESISE ASPECTS IN IT STUDY CHOICE THEORIES

The aspects in the IDT are augmented to focus on IT study choice by adding constructs from the abovementioned two studies' career choice models. The different aspects from the models are listed sequentially in Table 14, grouped according to the three main groups in the IDT: "Personal data", "Shaping and influencing factors" and "Environmental context". The last column contains all the relevant aspects and forms the Framework of IT Study Choice which is the theoretical underpinning of this study.

Table 14: Individual difference factors merged with study choice factors

Individual Differences Theory of gender and IT (IDT)			**TRA applied to gender for IS study choice (Croasdell, et al., 2011)**	**Model of girls' ICT study and career choices (Clayton, 2007)**	**Resulting Framework of IT study choice**
Personal data	Demographic data	Age			Age
		Ethnicity			Ethnicity
		Gender			Gender
		Nationality			Nationality
		Race			Race
		Religion			Religion
		Sexual orientation			
	Lifestyle data	Spouse or partner		Family	Spouse or partner
		Children			Children
		Family background			Family background
		Family work background			Family work background
					Socio-economics
	Workplace data	Career characteristics	Intended career or job		Intended career or job
		Industry type	Availability		Availability
		Job title	Security		Security
			Salary		Salary
		Technical level			Technical level
		Type of IT work			Type of IT work

Individual Differences Theory of gender and IT (IDT)			TRA applied to gender for IS study choice (Croasdell, et al., 2011)	Model of girls' ICT study and career choices (Clayton, 2007)	Resulting Framework of IT study choice
Shaping and influencing factors	Personal characteristics	Education		School type Curriculum and teaching	Education School type Curriculum and teaching Degree registered
		Interests and abilities	Genuine interest in IS field Aptitude, course workload, difficulty of IS major and IS curriculum	Aptitude	Interests and abilities Aptitude, course workload, difficulty of IS major and IS curriculum
		Personality traits		Personality	Personality traits
		IT identity	Personal image belief	Subjective task value Goals and self-schemata	IT identity Subjective task value Goals and self-schemata
		Gender identity			
	Personal influences	Exposure to computing		ICT-related resources School ICT access Home ICT access	Exposure to computing School ICT resource access Home ICT access
		Educational experiences		Teacher	Educational experiences
		Life experiences	Social image beliefs	Interpretations of experiences	Life experiences Social image beliefs
		Role models and mentors	Salient referents: family, friends, fellow students, advisors, professors	Role models	Role models and mentors Salient referents
Environ-mental context	Cultural attitudes and values	Attitude towards women, Women working, Women working in IT		Media ICT stereotypes Gender stereotypes	Media ICT stereotypes Gender stereotypes Attitude towards women, Women working, Women working in IT
		Academic attitudes towards women (in general, in IT)			Academic attitudes towards women

Individual Differences Theory of gender and IT (IDT)			TRA applied to gender for IS study choice (Croasdell, et al., 2011)	Model of girls' ICT study and career choices (Clayton, 2007)	Resulting Framework of IT study choice
		Workplace attitudes towards women (in general, in IT)			
	Geographic data	Location			Location
		Population			Population
		History			History
	Economic data	Employment overall			Employment overall
		Information economy employment			Information economy employment
	Policy data	Relevant laws and policies			Relevant laws and policies

3.4 RESULTING FRAMEWORK

The proposed IT Study Choice Framework retains the structure of the IDT, but focuses on study choice aspects. This allows a view on individuals at the stage in their careers when they are completing secondary school and deciding on what tertiary qualification to pursue. Whereas the IDT framework contains the workplace aspects of an individual who is already employed in the IT sector, the proposed IT Study Choice Framework assumes that the individual is a full-time student who may or may not have given thought to an intended workplace.

This assumption implies that the framework should be tailored to the point of view of a newly matriculated student. The selection rationale of the various aspects included, is now discussed according to each of the three constructs in IDT - Personal data, Shaping and influencing factors and Environmental context.

The Personal data construct consists of three subconstructs – "Demographic data", "Lifestyle data" and "Workplace data". Of the "Demographic data" subconstruct, the aspects

"Age", "Gender" and "Nationality" were included in the study choice framework. So too "Religion" despite its intended exclusion from the survey phase of the study. It was to be used during the interview phase and only presented to respondents to optionally comment on. "Sexual orientation" was omitted since the ethical committee would not allow the question posed to students. The closest the researcher could get to gather data on this aspect, was to allow each respondent to choose between three possible gender descriptions: "Male", "Female" and "Other". The demographic aspects of "Race" and "Ethnicity" were included in the framework, in spite of anticipated ethical committee refusal, since the intent of this study was to gather as complete a dataset as possible. (It so transpired that the researcher did not request ethical clearance for the aspect "Race" during the first survey run, yet had to submit a special additional request for its inclusion into the second survey administration.) All aspects of the "Lifestyle data" subconstruct were included, and an additional aspect "Socio-economics" was made pertinent by the researcher. Socio-economics aspects are a subset of "Lifestyle data" but it was given prominence in the framework since the country in which the research was performed happens to be one of the most socio-economically unequal countries in the world. At the point of writing, South Africa has the highest inequality rates in the world, with a Gini coefficient of 0.63 (Scott, 2019). This fact highlights the importance of gathering data on the socio-economic aspect of respondents' lives. The "Workplace data" subconstruct is changed to "Intended career data" while the aspect "Career characteristics" is changed to "Intended career" to reflect the career stage in which the respondents (being students) find themselves. The two aspects "Industry aspects" and "Job title" were not included since students in general have as yet had no experience thereof. "Technical Level" and "Type of IT work" were included and so too "Availability", "Security" and "Salary" from the TRA applied to gender (Croasdell et al., 2011).

The Shaping and influencing factors construct consists of two subconstructs – "Personal characteristics" and "Personal influences". "Personal characteristics" concepts such as "Education" are included and developed by adding "School type" and "Curriculum and teaching" from Clayton's Model of girls' ICT study choice (Clayton, 2007). In the same way, "Interests and abilities" are included and broadened by the TRA concepts "Aptitude", "Course workload" and "Difficulty of IS major and IS curriculum". "Personality traits" are

retained as is while the concept “IT identity” is supplemented with Clayton’s “Subjective task value” and “Goals and self-schemata”. The concept “Gender identity” is omitted from the study choice framework due to it being ethically problematic to ascertain. The subconstruct “Personal influences” is retained in full and supplemented by “School / Home ICT resource access” under “Exposure to computing”, while the aspect “Life experiences” is supplemented by “Social image beliefs”. The aspect “Salient referents” is added to “Role models and mentors” to enable the researcher to gather data on all the influencers in that individual students’ life.

The “Environmental context” construct consists of four subconstructs – “Cultural attitudes and values”, “Geographic data”, “Economic data” and “Policy data”. All of these are included in the framework, with the exception of “Workplace attitudes towards women”, which is not relevant to the study’s population. Three further aspects from Clayton’s model are added to “Cultural attitudes and values”, being “Media”, “ICT Stereotypes” and “Gender Stereotypes”.

In creating the Framework of IT Study Choice, the three levels of influence (Personal, Shaping and Environmental constructs) were arranged concentrically. This structure was chosen since it is expected that an individual’s science identity, which can be considered fixed by the age of 18, will override environmental influences such as gender stereotypes or cultural attitudes towards women working in IT. The IT Study Choice Framework is illustrated in Figure 9: The IT Study Choice Framework.

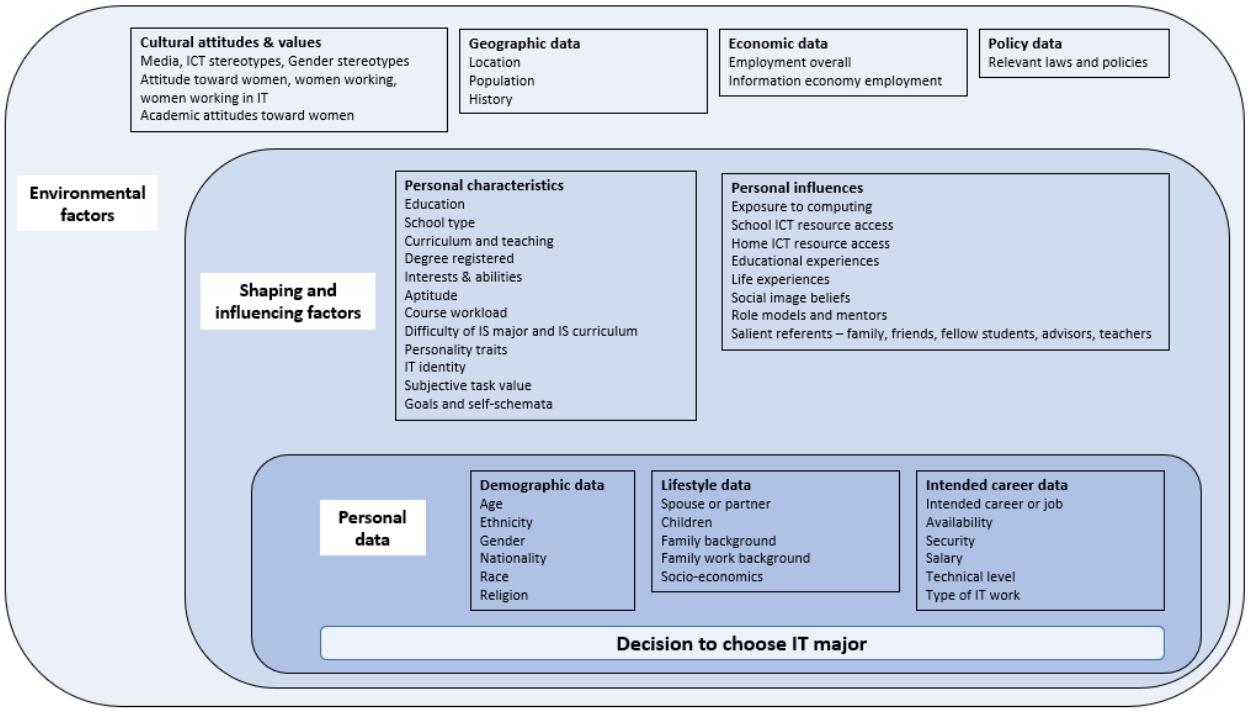


Figure 9: The IT Study Choice Framework

The IT Study Choice Framework will be applied in a mixed methods study by forming the underlying theory from which a quantitative phase is executed, followed by a qualitative phase.

The first phase will consist of a quantitative study following the hypothetico-deductive approach described by Cohen (2016). The approach is illustrated in Figure 10. In this research model, there are four stages to be traversed: theory, hypotheses, data collection and data analysis (results). In the hypothetico-deductive approach, the researcher selects a theory to test. The theory is used to create hypotheses. This is also called the hypothesised research model. Data is collected and analysed. Each hypothesis is subsequently tested. When the results fit the hypothesis, that part of the theory is proven. When a result and hypothesis contradict each other, that part of the proposed theory is falsified.

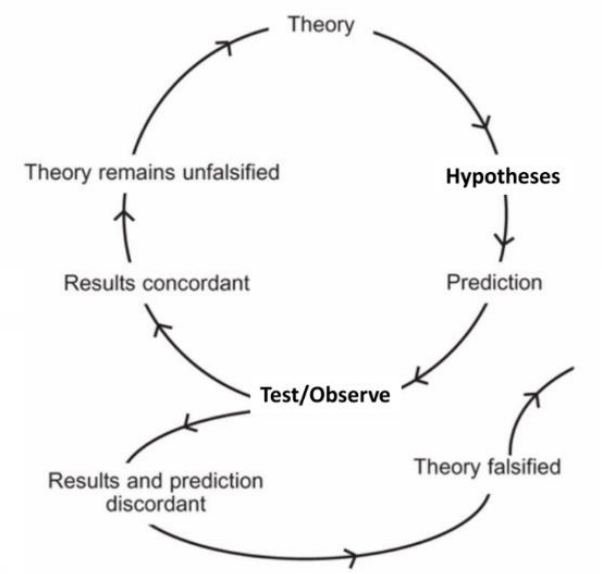


Figure 10: Hypothetico-deductive relational research

Source: (Cohen, 2016)

From the IT Study Choice Framework, five hypotheses are proposed (see Figure 5). The concentrically arranged spheres of influence indicate each level's influence on the next, as well as each sphere's influence on the individual's choice of study.

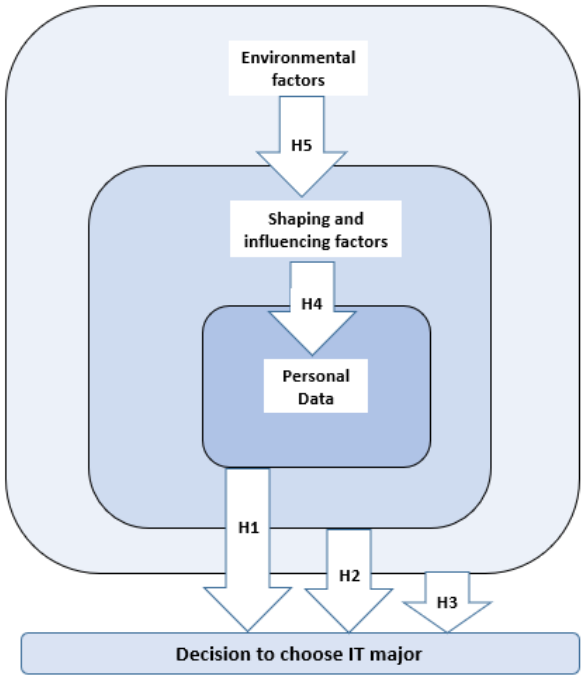


Figure 11: The hypothesised research model of the IT Study Choice Framework

The hypotheses are as follows:
H1(+): Personal data factors (demographic, lifestyle and intended career) have a positive influence on South African first-year female students' decisions to major in IT.

H2(+): Shaping and influencing factors (personal characteristics and personal influences) have a positive influence on South African first-year female students' decisions to major in IT.

H3(+): Environmental factors (cultural attitudes and values, as well as geographic, economic and policy data) have a positive influence on South African first-year female students' decisions to major in IT.

H4(+): Shaping and influencing factors have a positive influence on personal factors in South African first-year female students' decisions to major in IT.

H5(+): Environmental factors have a positive influence on shaping and influencing factors in South African first-year female students' decisions to major in IT.

These hypotheses will be tested in a quantitative study that forms phase 1 of the study. The survey instrument is an online questionnaire, with the questions based on the aspects defined in the IT Study Choice Framework.

3.5 IDENTIFYING A THEORY TO INFORM DATA INTERPRETATION

Information systems are social systems and technology is socially shaped. Therefore a sociological lens can and should be applied to study the technology workforce and the motivations of the people acting within that workforce.

3.5.1 Pierre Bourdieu's Theory of Practice

The French sociologist Pierre Bourdieu (Bourdieu, 1984) constructed a general theory of practice by using an economic metaphor. His theory attempts to explain power and social status in a human society. Bourdieu sees culture as the core of the economy, the economy being the economy of symbolic goods. Although his work pertained to class hierarchies in human society, and is anchored in ethnography, the intellectual tools he created can be used to study a wide variety of sociological phenomena.

Bourdieu describes society as consisting of (a history of) individuals occupying social space, living in it and producing it (sometimes called "structure" versus "agency"). People are free-willed but they live in a social world where they are constrained by the structure of society as well as their own personal principles. Society consists of a variety of fields where what is valued in that field is called "capital". All individuals strive for capital - whether it be cultural, economic or social. One type of capital is also, to a degree, convertible to another type of capital. The logic of practice involves individuals developing strategies of behaviour to exist within the social world. Habitus makes it work for each individual by guiding the person's practice and behaviour in everyday life.

Bourdieu's work provides an alternative for dealing with the seemingly irreconcilable and opposing perspectives of subjectivism and objectivism. In translating his work to an American audience, Bourdieu himself termed it "constructivist structuralism". By "constructivist" he emphasises that his methodology is subjective and focuses on the social generation of mental structures. Through using the word "structuralism" Bourdieu emphasises the objective structures that unconsciously act to orient social practice. He describes the perception of the social world as being the product of a double structuration between subjective and objective aspects. Using Bourdieu's approach, the world can be seen as being available to the many possible structurations which both create fields and are created by them. As such, the social world is changing continuously by those who struggle for the dominant vision. Examples would be the struggles between class divisions, the struggles between ethnic groups and the struggles between genders.

Bourdieu's approach is necessarily complex, since it mirrors social reality, and "is designed to understand both the genesis of social structures and of the dispositions of the habitus of the agents who live within these structures." (Harker, Mahar and Wilkes, 1990, p.4). The terms *habitus* and *field* are two main conceptual tools which are crucial to Bourdieu's work, together with the concept of *strategy* which drives the human struggles for power (both symbolic and material) and capital (economic, cultural and symbolic).
The main concepts of Habitus, Field and Capital are now shortly discussed.

3.5.1.1 Habitus

This is Bourdieu's most important concept. He defined habitus as being a system of durable characteristics of a person that forms the basis of that individual's practices. It is the dispositions that people accumulate throughout their life, and accounts for their attitude and behaviour towards things.

Habitus is durable because it is maintained throughout an individual's life. It allows field theory to account for people's actions within fields. Bourdieu distinguishes between two types of habitus: primary and secondary. Primary habitus is the system of dispositions that an individual embodies through socialisation in the family environment in his or her childhood. Primary habitus is stable. Secondary habitus is built on primary habitus, and develops from educational experiences and an individual's life experiences in adulthood.
Habitus is transposable because skills in one field can likewise be productive in other fields. An example is painting and photography. The skills of colour and composition learned in painting can be used as effectively in photography.

Habitus includes a person's own knowledge and understanding of his or her world, and is never fixed, neither through the lifetime of the individual nor from one generation to the next. In situations of rapid change, the conditions of the social environment are not the same for the new generation. Therefore Habitus is a mediating construct, not a determining one. Habitus is intimately linked to capital, an example being the habitus of the dominant social and cultural factions in society exhibiting high symbolic capital (status) (Bourdieu, 1984).

3.5.1.2 Fields

A field is any context (social or professional) in which agents (individuals) vie for reputation. Examples of fields are education, art or birdwatching. The concept of “field” should be seen as a ‘field of forces’, since it is dynamic. There is a constant struggle for positions within it. Positions of actors in a field depend on the specific capital an individual possesses.

Different capitals are viewed differently in each field. Fields are not autonomous, they are linked by the field of power. The field of power consists of the fields of economy and politics combined. These two fields have a direct effect on any of the other fields.

3.5.1.3 Capital

Bourdieu’s definition of capital is any resource that can produce surplus value once set into a circle of exchange. An example of a resource is social connections, and an example of invested surplus could be a gift which will be reciprocated at a later time. The definition of capital is very wide and can include physical things (which can have symbolic value) as well as culturally significant things such as status and authority (called symbolic capital) and cultural capital (culturally valued consumption patterns) (Bourdieu, 1986).

Capital is “convertible” in the sense that one type of capital can be exchanged for another type of capital. A simple example is the money that a parent pays an educational institution which gets converted into a universally recognised qualification for the child. The various forms of Capital are illustrated in Figure 12.

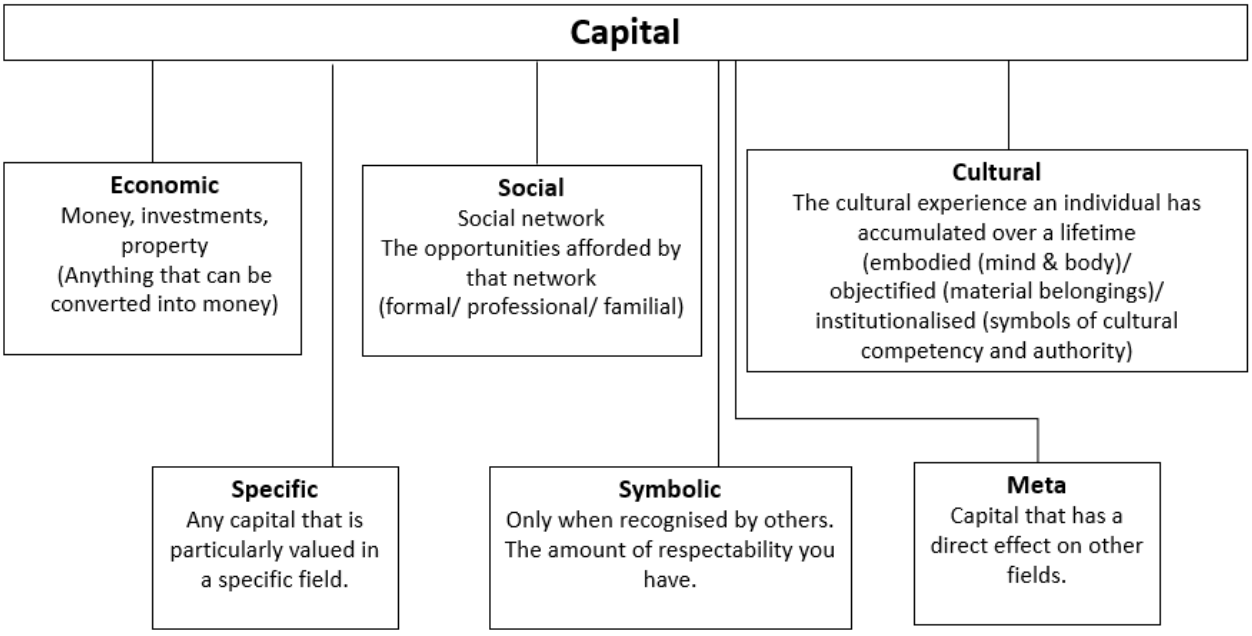


Figure 12: Bourdieu's forms of capital

Capital moves in a cycle, being transferred from one person to another (labour or time). An example of the cycle of capital is the movement of capital from cultural capital to social capital (by adding influential people to your circle of friends), from social to economic capital (gaining property through your social connections), and from economic capital back to cultural capital (by being able to attend events where you can meet more powerful people).

The fields of politics and economy are said to possess meta capital since they have a direct effect on all other fields. An example is the field of media, which can influence the relative value of different fields within society.

The three well-known concepts Capital, Habitus and Field are supplemented by three lesser-known concepts termed Nomos, Illusio and Doxa.

3.5.1.4 Nomos

Nomos indicates the field-specific norms that regulate the actions of agents in a field; these are unspoken but universally understood. They are the products of historical struggles by the agents in a field, over which forms of capital are valuable for that field. It sees a particular

vision of a field as the legitimate vision, and at the same time divides the world into categories of individuals or practices. An example of Nomos is social class, which is both a vision and a division of society. Social class is also a result of pre-existing economic relations.

3.5.1.5 Doxa

Doxa describes the underlying and therefore unquestioned beliefs that are commonly held in a field. Doxa can be described as the state when the socially constructed is perceived by the individual as the natural order and therefore accepted. An example of Doxa is women's magazines giving advice on "etiquette" where the readers assume that all that is required is to learn the rules. Bourdieu shows that manners deliberately learned, actually signal a lack of symbolic capital. An individual's behaviour is only seen as being legitimate when it is acquired from the family through primary socialisation.

3.5.1.6 Illusio

Illusio is a belief held by all agents in a field that the rewards of that field actually hold value. An example is parents who are both lawyers, disagree with their son who wants to become a dancer. For people beyond the doxic effects of the field, the value can appear illusionary.

In a very simplified form, Bourdieu's social practice can be represented as the following generative formula (Bourdieu, 1984,p 101):

(Habitus x Capital) + Field = Practice

This formula is used as an explanatory device, and should in no way be seen as a universal solution. It merely summarises the relation between the major concepts in Bourdieu's theory.

3.5.1.7 *Practice*

The concept of Practice, as in the formula above, describes the actions of an individual or group as the result of the interaction of habitus and field. (In studying a particular field, the formula should be read from right to left). Only through the study of *particular* practices can a field be delineated and the forms of capital identified.

The concept of "strategy" sets Bourdieu's work apart: the ongoing interaction between objective and subjective structures, as in Giddens' "structure" and "agency". Individuals constantly struggle for positions in the field. However, as can be seen from the generative formula above, the outcome of practice is unpredictable for individual agents. Given that an individual agent can take up any number of positions within any number of autonomous fields, and that habitus is not totally determined by structures, the agent has considerable room for manoeuvring by adopting various strategies. Agents construct their social world and act to gain position therein.

The perspective which Bourdieu offers is a complex method for the social sciences, and is necessarily simplified for the context of this dissertation, but it gives us conceptual tools we can use to analyse a "complex reality" (Harker et al., 1990).

3.5.2 Applying Bourdieu's concepts to the current study

The social theory of Pierre Bourdieu (Bourdieu, 1986) is used as a lens to interpret the results found in the current study. The goal is to uncover how society and culture influence a student's decision to major in Information Technology. To simplify Bourdieu's theoretical concepts, we employ his "thinking tools" which consist of the concepts field, habitus, (logic of) practice and capital. Bourdieu's "thinking tools" are summarised in Table 15: A summary of Bourdieu's "thinking tools" and how it applies to this study. and each item description is followed by its application in the context of the current study (Routledge, 2011).

Table 15: A summary of Bourdieu's "thinking tools" and how it applies to this study.

Term		Description
The logic of practice		The relationship between social actors constructing their social reality and the social structure both constraining and enabling their agency. (In this study the actors are the students and the social reality is the studies they pursue, whether it be STEM, Non-STEM or IT qualifications.)
Field		The objective social relations and structures that govern the actions of actors in social situations. (In this case it is the field of available majors at tertiary institutions and the skills required in this field.)
Habitus		Human agency, or the various forms of behaviour and dispositions that people acquire through acting in society. (In this case it is students pursuing STEM or IT qualifications at tertiary institutions). Habitus is not fixed, but in constant negotiation with the world.
Capital		Capital forms the foundation of social life, dictating the individual's position within the social order – more capital implies a more powerful position in society, economically as well as culturally. It refers to symbols such as manners, clothing, postures, material belongings and credentials. Similar forms of cultural capital shared with others form collective identity but can be a major source of social inequality. Cultural capital influences an individual's social mobility just as much as the possession of wealth does.
	Social Capital	All the resources linked to a network of relationships of mutual acquaintance and recognition, i.e. membership in a group, like a family, or being enrolled for a degree at a university.
	Cultural Capital Cultural capital comes in three forms: *Embodied , Objectified and Institutionalised*	*Embodied cultural capital* refers to the accumulation of cultural capital in the embodied state, personally by the investor. The acquisition cannot be done second-hand. An example is a student who acquired a university degree. *Objectified cultural capital* is a material object which is defined in relationship with embodied cultural capital, such as a painting or a student's writing. *Institutionalised cultural capital* is objectified cultural capital in the form of credentials and qualifications such as degrees or titles. These symbolise cultural competence and authority, and do not have the same biological limits as its bearer.
	Symbolic Capital	Prestige associated with cultural capital such as a university degree.
	Economic Capital	Possession of material wealth or the access to it, such as being able to afford a university degree, either with savings or being awarded a bursary.
	Technical Capital	The skills specific to engagement with modern computing technology.

The logic of practice in this study is the relationship between the students (actors) and the qualifications they pursue (in this case, the university forms the structure within which they perform). The field is therefore the academic field and in particular, tertiary studies. Habitus

is the continually changing dispositions that students acquire on their academic journey. Capital is the most salient aspect of Bourdieu's theory to this study, since the attainment and possession of a tertiary qualification immediately elevates an individual in society. There are many forms of capital that a university graduate aspires to: symbolic capital in the form of prestige in holding a degree, technical capital in the form of (computing or other) knowledge attained, and anticipated economic capital in the form of substantial salaries or income upon attaining employment.

The concepts described in this section will be used to interpret the findings of the study.

3.6 CONCLUSION

This chapter described the search for a suitable gender-and-IT theory to be used as a theoretical base of the study. All publications in leading IS journals pertaining to gender studies were investigated to determine how they theorise gender. Only papers that explicitly employ theorising were investigated and a list of gender and IS theories were created. A contemporary gender and IT theory was identified from this list, and augmented by two career theories from the same list. A sociological theory intended to be used in interpretation of the data, was also identified and its application to the topic of this study was described.

4 METHODOLOGY

4.1 INTRODUCTION

Every research project follows its own unique research plan, a “roadmap” showing how the researcher got from start to finish. This chapter describes the research approach adopted for this study together with the procedures of enquiry that were followed. It then details the research methods used. The chapter is rounded off by a description of ethical issues encountered during the research process.

Figure 13: Chapter Map provides a graphical snapshot of the chapter structure.

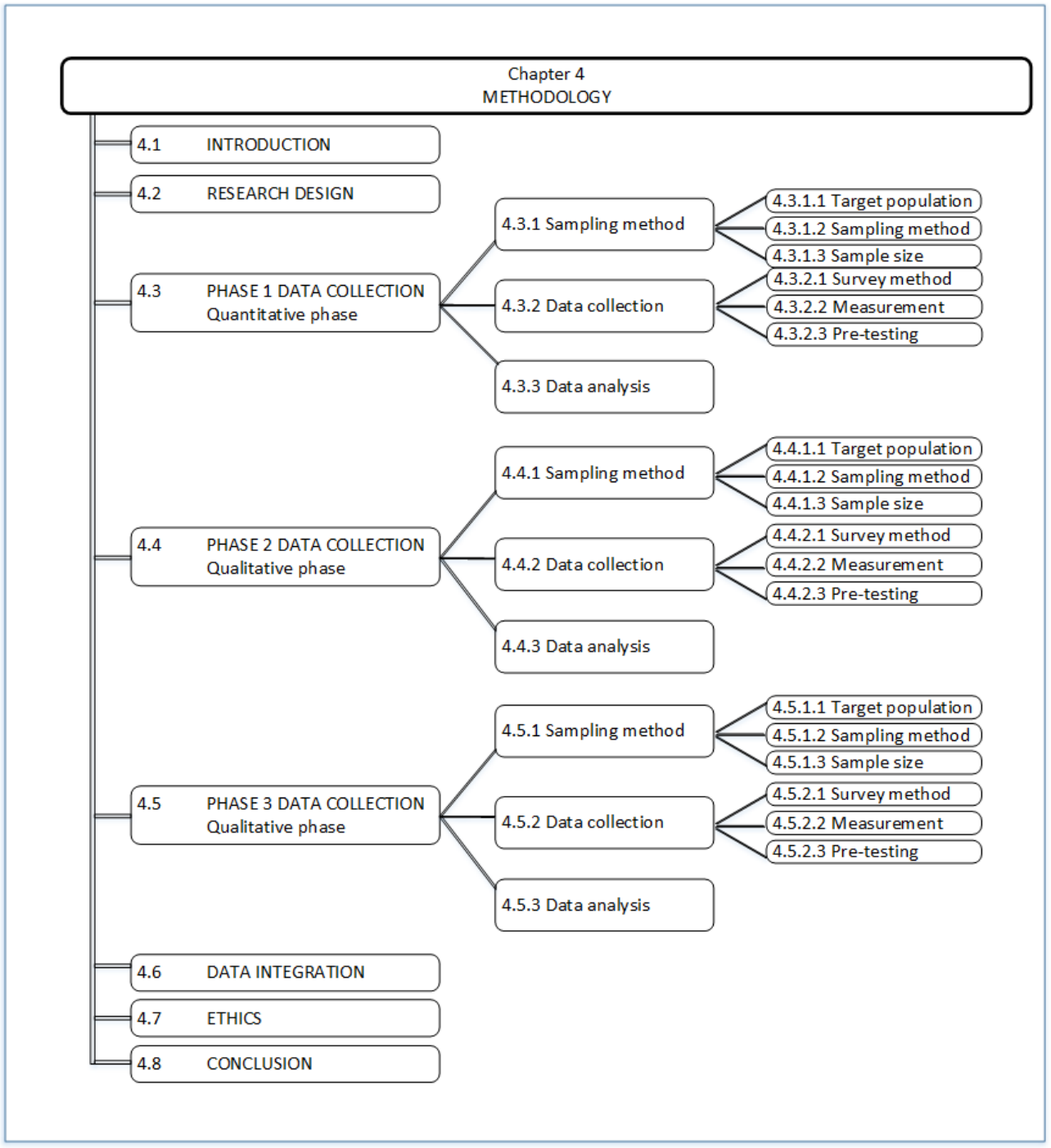


Figure 13: Chapter Map

4.2 RESEARCH DESIGN

Information systems are by definition social systems. This means that researchers working to understand human aspects in the field of information systems, find themselves assuming

the role of social scientists. Every such individual applies their own set of assumptions about the essence of their study. These assumptions or belief sets need to be clearly articulated at the start of the research project, since they influence the way the research is done.

Burrell and Morgan (1979) created a scheme for the analysis of social theory, consisting of four overarching sets of assumptions. Each set characterises a different and mutually exclusive approach to social theory. Researchers in information systems need to be aware of these underlying schemes, position their research accordingly and discuss their approach explicitly at the outset of the study (Creswell, 2014). This is because each scheme, or "intellectual territory" as Burrell and Morgan (1979) call it, implies different underlying assumptions which in their turn demand different research strategies and methods. When a researcher manages to explicitly state his assumptions in a study, and implement a relevant research strategy, his potential contribution to the research community is greatly increased. Clearly specified philosophical assumptions therefore improve knowledge dissemination, a basic tenet of the research community, since readers are then better able to understand the author's frame of reference.

Burrell and Morgan's (1979) discourse in social theory provides researchers with a firm footing upon which to position their approach to social science. They found that "all theories of organisation are based upon a philosophy of science and a theory of society" (Burrell and Morgan, 1979, xii). These aspects provide two dimensions of analysis, from which they defined four basic paradigms that each reflects a separate view of social reality. The four different research paradigms are labelled functionalism, interpretivism, radical structuralism, and radical humanism (see Figure 14).

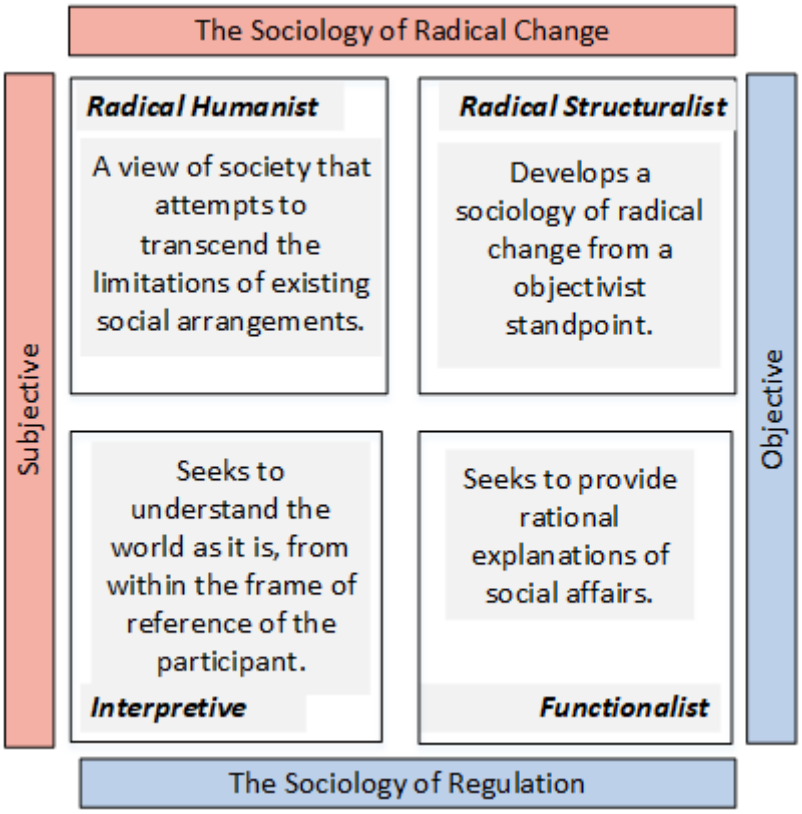


Figure 14: A scheme for analysis of social theory (adapted from Burrell and Morgan, 1979)

The functionalist paradigm is concerned with explaining how the various individual elements of any social system, interact in order to form an integrated whole. On the opposite side of the regulation / radical change continuum lies the radical structuralist paradigm which supports a view of society and organisations, stressing the need to overthrow or transcend limitations placed on any existing arrangements. These two paradigms imply a more objective approach to research. A subjective approach to research is possible in the other two paradigms. The interpretivist paradigm seeks explanation within the realm of individual consciousness and subjectivity, and within the frame of reference of the participant. The radical humanist paradigm seeks radical change, focusing on all forms of barriers to emancipation and ways to overcome them. Burrell and Morgan's (1979) scheme offered a form of "intellectual map" upon which existing literature can be plotted and new social science studies can be positioned, providing a common point of reference for dissemination and discussion.

This notion of four basic paradigms underlying the study of organisational sciences was consequently embraced by information systems researchers. So much so, that twenty years later, Goles and Hirschheim (2000) comment on the “rather surprising importance Burrell and Morgan's notion of paradigms has played in the conception of the field's philosophical discussions” (Goles and Hirschheim, 2000, p. 1). They find that despite this solidarity, or ironically possibly because of Burrell and Morgan's insistence that their four paradigms are mutually exclusive, many researchers have since been moving towards adopting multiple paradigms in a single study.

The multiparadigm approach is grounded in the philosophical school known as pragmatism, where the general consensus is that researchers should conduct their particular study using whatever philosophical or methodological approach works best for them (Goles and Hirschheim, 2000; Teddlie and Tashakkori, 2012; Johnson, Onwuegbuzie and Turner, 2007). The pragmatic approach allows the researcher to rise above restrictions imposed by any single paradigm in order to investigate a research problem from more than one angle. Using more than one approach allows the researcher more views of a particular phenomenon, permitting a more comprehensive understanding of the problem (Goles and Hirschheim, 2000). Mitchell (2018) echoes the sentiment by concluding that the combination of numerical and cognitive reasoning leads to a better answer than could otherwise be found by one method alone (Mitchell, 2018). He also mentions that a further advantage of using a multi-method approach is that it can lead to “subsequent management decisions that reflect both the interplay of social and scientific aspects of the world today” (Mitchell, 2018, p. 1).

The issue of female under-representation in the information technology workforce is precisely the issue mentioned by Mitchell (2018), being an interplay of social and technological aspects in our world today. As such, a properly planned and integrated combination of quantitative and qualitative methods provides an effective way to research the issue.

4.2.1 Philosophical underpinning of this study

The philosophy underlying a body of research is the foundation on which the research methods are chosen. It comprises a number of elements, the most salient of which are the ontological and epistemological components. Ontology refers to a researcher's existing assumptions about reality. It ranges from whether they view the world as existing independently from the observer, through to the social world being a mental product of the observer. Epistemology refers to how a researcher believes that knowledge is gained, ranging from knowledge being external to an individual, to knowledge gained due to an individual's experiences in life. Put together, these two philosophical dimensions describe "what the researcher knows and how they gain knowledge" (Baldwin, 2014, p.1).

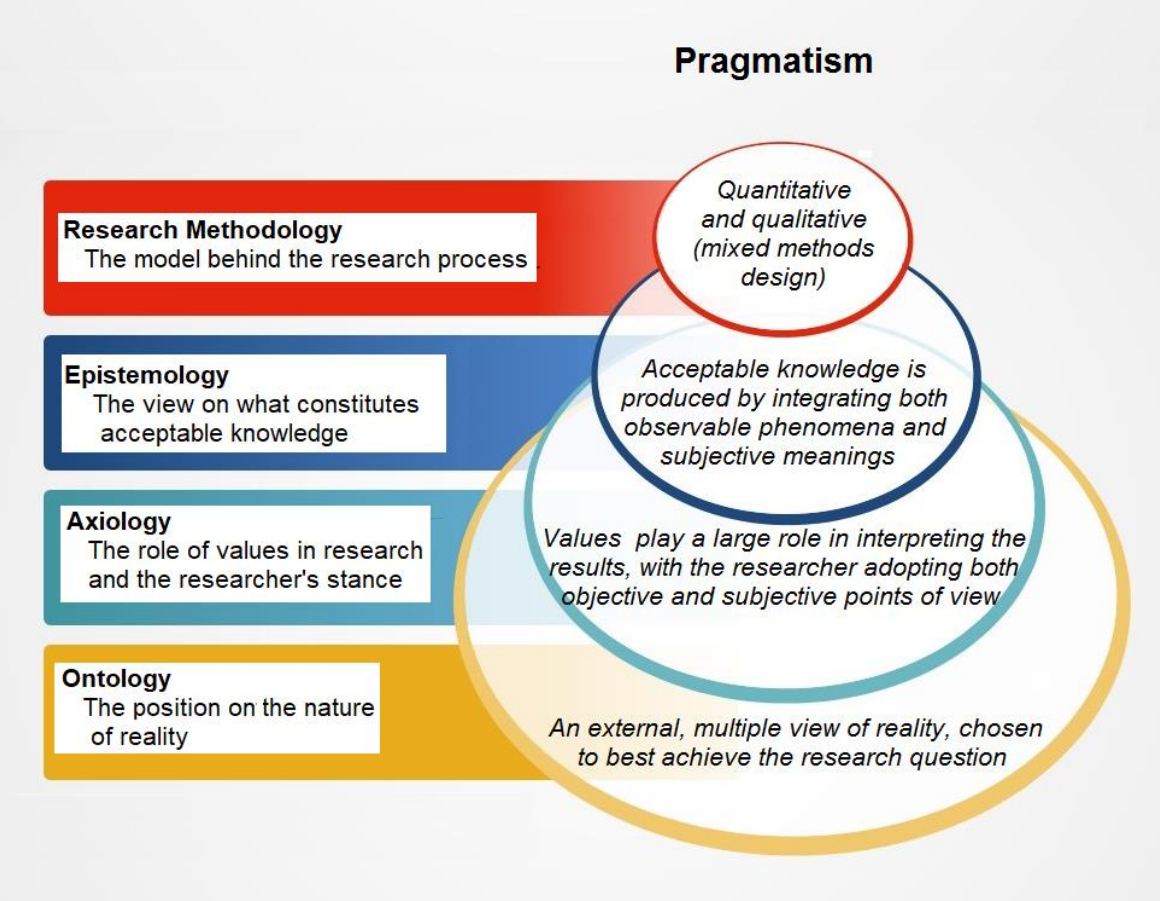


Figure 15: Philosophical Dimensions of the Pragmatic Research Paradigm in the Social Sciences (Adapted from Wahyuni, 2012).

The ontological position of the researcher investigating female under-representation in the information technology is one of an external observer, occupying multiple views of reality. The views employed to investigate the research question, are those that offer the best insights to the problem. This implies that the researcher adopts both objective and subjective points of view during the research process. This in turn implies that epistemologically, valid knowledge is produced by integrating both empirical and subjective data. Employing an integrated combination of quantitative and qualitative methods is known as a mixed methods approach to investigating a sociological phenomenon.

4.2.2 Mixed methods

Mixed methods research is considered a new methodology (Creswell, 2014). It originated in the late 1980s and early 1990s and has gone through several periods of development as well as expansion into different disciplines worldwide (Creswell & Plano Clark, 2011). Mixed methods research currently stands as a third popular approach following the widely accepted quantitative and qualitative research approaches. A number of different terms are used – ‘multimethod’, ‘mixed methodology’, ‘integrating’ and ‘synthesis’, but the most recent writings have used the term “mixed methods”. A mixed methods approach to establishing knowledge considers multiple perspectives. Creswell defines it as, “Mixed methods research is an approach to inquiry involving collecting both quantitative and qualitative data, integrating the two forms of data, and using distinct designs that may involve philosophical assumptions and theoretical frameworks” (Creswell, 2014, p. 5). The aim is to combine both quantitative (close-ended data, numbers) and qualitative (open-ended) data in an attempt to arrive at a more complete understanding of a research problem, which is better than using only one of the two approaches alone (Bryman, 2006; Creswell, 2014). However, while two data gathering approaches undeniably generate richer data than only one, care should be taken as to how and when the results are combined (Bryman, 2006). Morse and Niehaus (2009) discuss integrating data from two designs by suggesting the location of various integration points during the process.

Mixed methods research offers value at three levels:

- in *general* it exhibits strength because it draws on both quantitative and qualitative research,
- *practically* it provides a sophisticated approach to research using these two data types,
- and *procedurally* it is a useful strategy to acquire a more complete understanding of research problems (Creswell, 2014).

Mixed methods research is unique in a number of ways. Creswell (2016) lists five characteristics which he identifies as essential of Mixed Methods research:

1. the collection and analysis of both quantitative and qualitative data, in response to the research question or hypotheses posed;
2. demonstrating rigour in conducting quantitative and qualitative research;
3. combining or integrating findings from the quantitative results as well as the qualitative findings;
4. developing procedures in which this data collection, analysis, and integration occurs. These are called the mixed methods designs; and
5. using and stating both philosophy and theory as it relates to the abovementioned procedures.

Creswell (2016) identifies a number of mixed methods designs (convergent and sequential) as well as various frameworks (intervention, participatory, program evaluation, case study and survey) together with their specific challenges.

4.2.3 Selection of a research approach

This study employs a sequential mixed methods design. It entails conducting a quantitative study with two follow-up qualitative studies. It is considered sequential because each phase of data collection and analysis is completed before the next phase starts. A sequential mixed methods design is characterised by the following aspects (from Creswell (2014)):

- different perspectives are compared as drawn from both quantitative and qualitative datasets;
- quantitative results are explained with qualitative follow-up and data collection and analysis;

- better measuring instruments are developed by first collecting and analysing the quantitative data and then adjusting the instrument to gather the qualitative data.
- better understanding of experimental results is gained by incorporating the perspectives of individual participants; and
- developing a better understanding of the need for and of the impact of an intervention program through collecting both quantitative and qualitative data over time.

Justification for choosing the sequential design lies in the attempt to create as comprehensive a dataset as possible. The aim of the study was to identify factors that influence the decision of female first-year students to study IT qualifications at South African universities. Considering that 3 decades' research has already been performed on the subject of IT study choice, the researcher decided to first identify a contemporary theory of gender and IT on which to base the study. The constructs in the theory had to aid in finding "important new information about the phenomenon being studied" (Ploeg, 1999b, p. 37). The theory was used to create an online survey pertaining to the participants' study choice. The initial survey results gave a snapshot of the numbers and genders of students registered for various degrees, but an in-depth follow-up study was necessary to discover the reasons behind them making the decision to register for their chosen degrees.

A mixed-methods research design was made possible in this study due to the fact that the researcher had longitudinal access to the research subjects. This was because most respondents to the first quantitative survey had returned in the following year for their second year of study. The researcher was therefore able to contact respondents of both questionnaire surveys and invite them to focus groups or interviews.

A visual model of the research process is indispensable and acts as a "road map" for both researcher and reader. A visual model of the research design of this study is presented in Figure 16. It shows the initial (quantitative) phase followed by two (qualitative) phases, with the last phase being the integration of all phases' data.

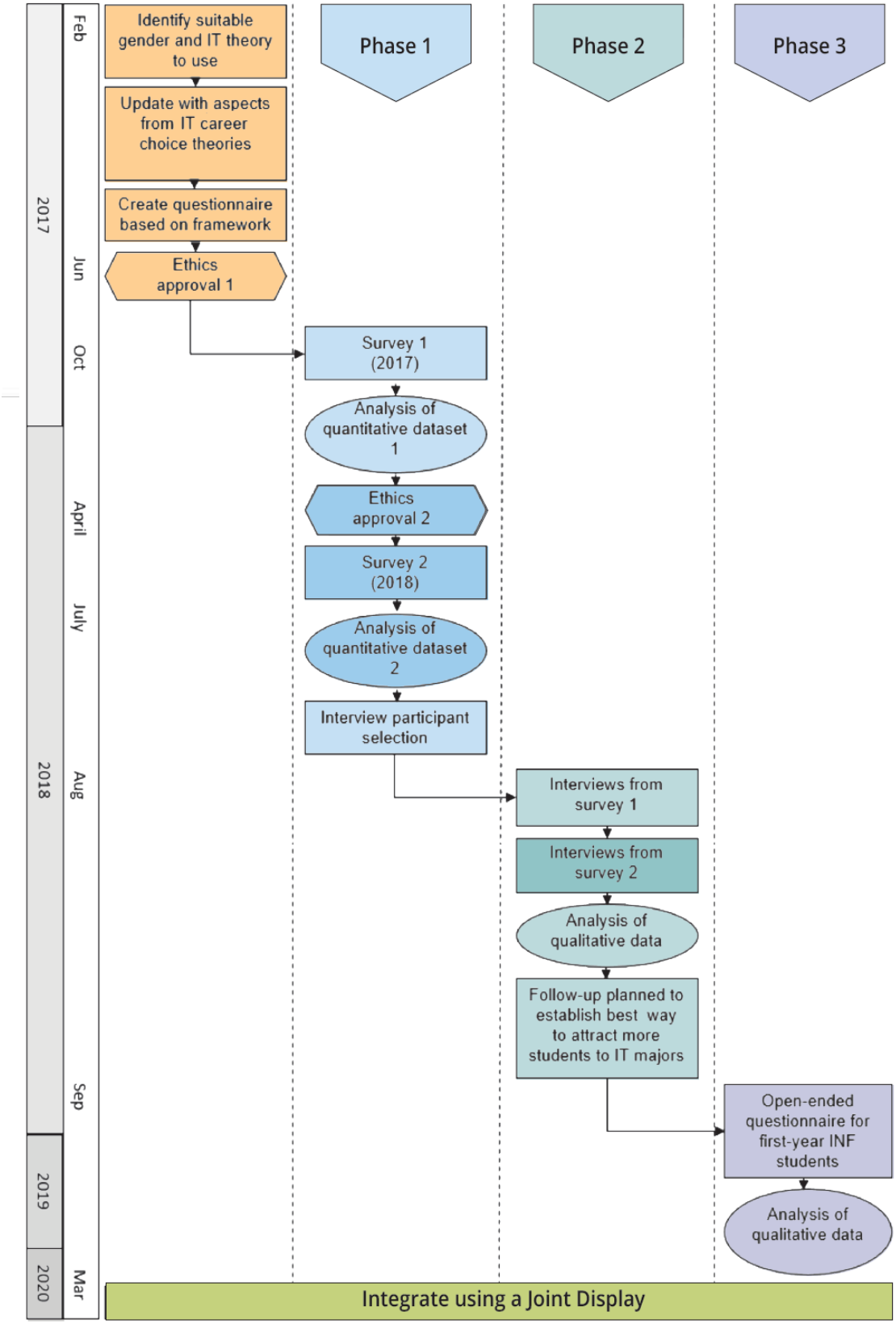


Figure 16: The Mixed Methods Design Map for this study.

This type of research design presents several unique challenges for the enquirer. Conducting a mixed methods study is time-consuming due to two or more phases of research having to be completed. It also demands skills in analysing both quantitative data as well as qualitative data. In such a study it is vital that data collection and analysis are performed rigorously. The last phase of the sequential mixed methods design requires that the data of all the phases be integrated. A challenge here is managing the unequal sample sizes of the various data collection phases.

The sampling, data collection and data analysis in all the phases of the sequential mixed methods design, need to be discussed separately. The overview of the discussion can be seen in the chapter map in Figure 17. It provides an eagle's-eye view of the steps followed in collecting data for this study.

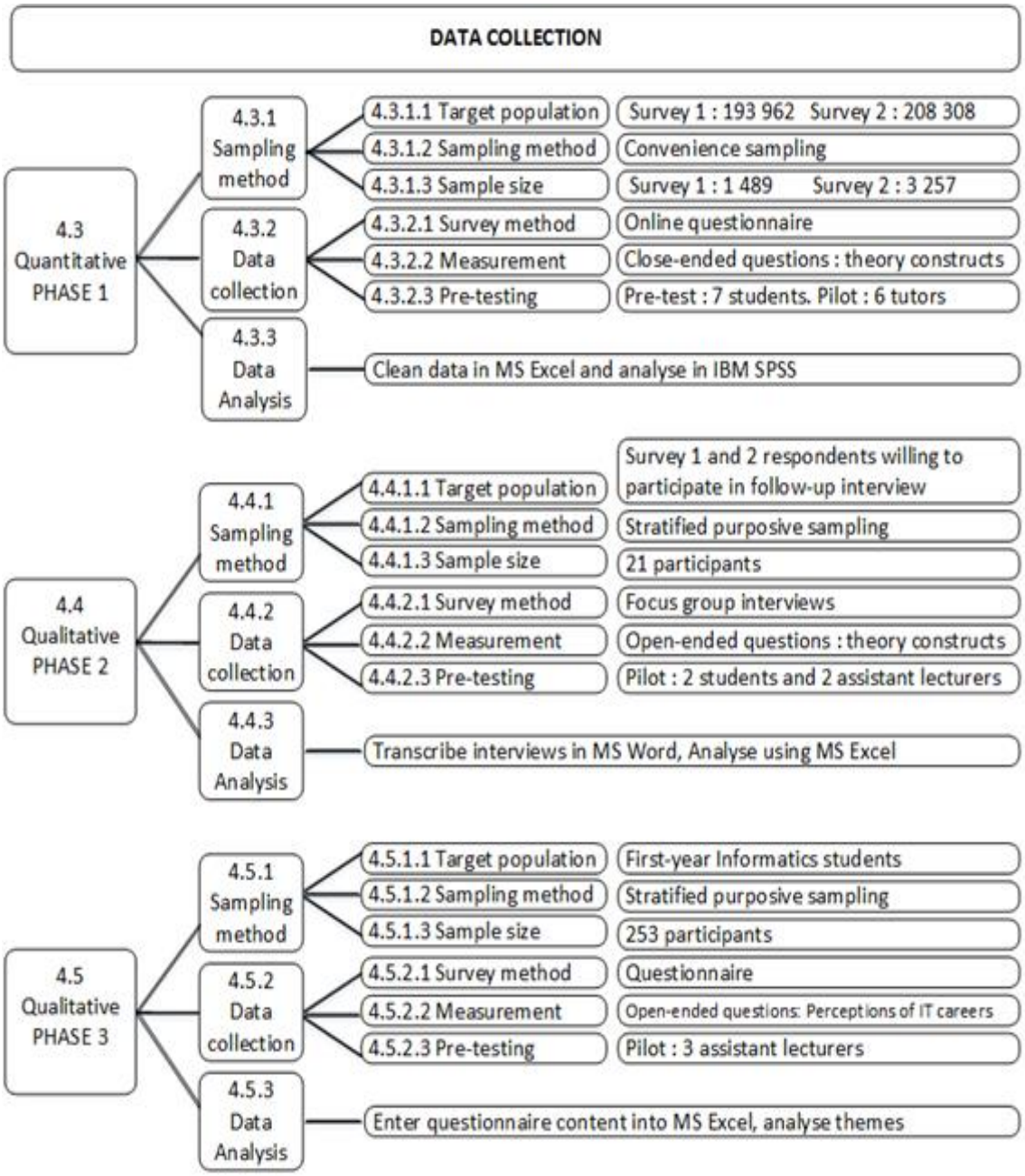


Figure 17: Data collection at-a-glance

4.3 PHASE 1 DATA COLLECTION – QUANTITATIVE PHASE

The approach to sampling, data collection and data analysis is now described, as performed for the first phase of the study.

4.3.1 Sampling method

4.3.1.1 Target population

The target population for this study consists of all the first-year students registered at the universities in South Africa. There are 26 public universities spread over South Africa, with a total number of students numbering just over a million, almost 20% of which are first-year students (Africa Check, 2016). Figure 18 illustrates the actual numbers of first-year students enrolled at South African public universities during 2017 and 2018.

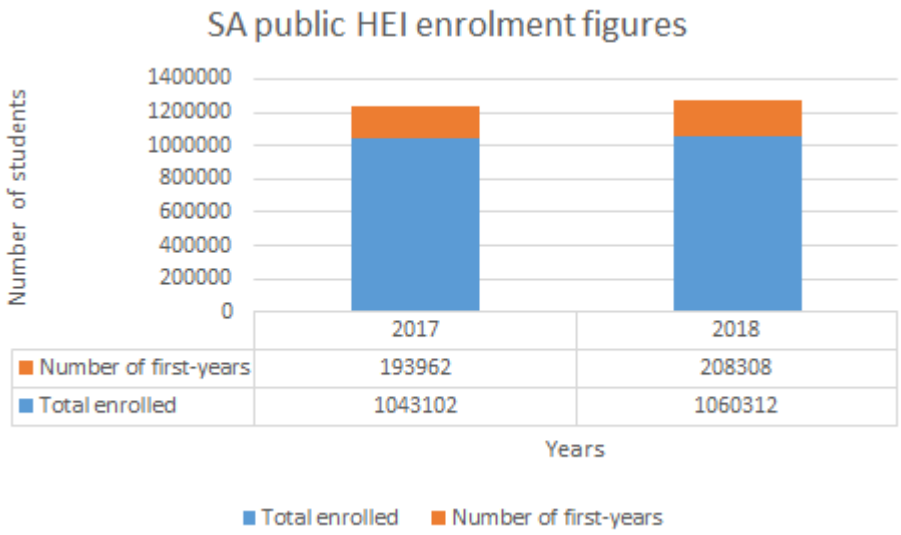


Figure 18: Number of students enrolled at South African public universities : 2017 and 2018

The three largest universities according to number of registered students, are UNISA (University of South Africa), North-West University and the University of Pretoria ((Staff writer, 2015). These numbers are depicted in Figure 19. UNISA is a distance education (DE) university and therefore is the largest university in terms of student numbers. The other universities are residential universities.

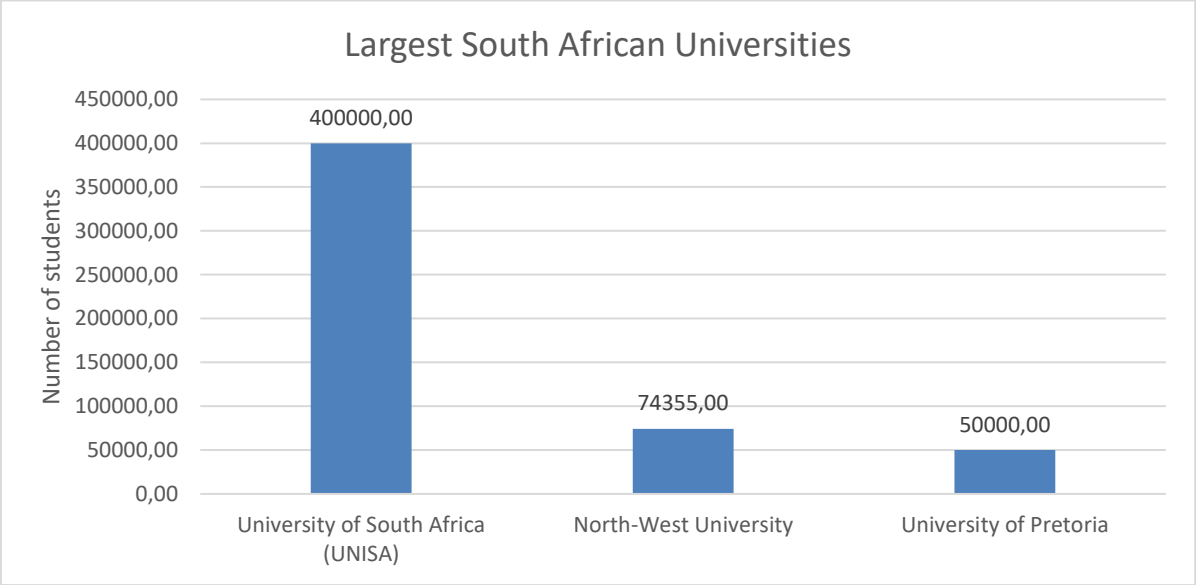


Figure 19: The three largest universities in South Africa according to number of students

The study under discussion was performed at the University of Pretoria, which is the second largest residential university in South Africa. It is a metropolitan university with a demographically representative student population. Approximately 8000 new students register at the University of Pretoria every year. These students formed the sampling frame for this study.

4.3.1.2 Sampling method

A non-probability sampling approach was followed in the form of convenience sampling. The drawback of non-probability sampling is that the researcher cannot know how well the sample represents the population. In the case of this study the researcher was fortunate to gain access to a large percentage of first-year students via a first-year module which is presented bi-yearly in one of the university's computer laboratories.

In support of one of the strategic goals of the University of Pretoria, a module called the Academic Information Management (AIM) module is presented in each semester, to ensure that all University of Pretoria students are computer and information literate by the time they graduate. Most first-year students register for the module, with the exception of engineering and medical students, who are exempt from the module since it is assumed that they already

possess the basic necessary computer literacy when starting their studies. Any resulting bias is minimal since the Engineering and Medical students form a minority. The module is presented in one of the UP computer laboratories, called the Academic Information Management (AIM) Labs. Another course called INF282 is also presented at the AIM Labs and is an introductory Pastel course for second-year accounting students.

These modules presented the ideal opportunity to conduct an online survey of first-year and second-year students. The students were encouraged to complete the questionnaire in class before the first lecture session started, while all were present. A small number of students completed the survey after class in their own time. Table 16 represents the number of students requested to complete the survey.

Table 16: Total number of students registered for the AIM modules during 2017 and 2018

Year	AIM Lab modules	UP Campuses			Total students
		Hatfield	Groenkloof	Mamelodi	
2017	AIM121	3544	495	699	
	AIM102	764			
	INF282 Pastel only	561			
		4869	**495**	**699**	**6063**
2018	AIM121	4738	909	894	
	AIM102	608			
	INF282 Pastel only	546			
		5892	**909**	**894**	**7695**

4.3.1.3 Sample size

In total, 3764 completed surveys were received from the two surveys: 1518 responses in 2017 and 3289 in 2018 (see Figure 20: Survey completion dates with corresponding number of responses). It depicts the number of surveys attempted on the corresponding days during the time the survey was available online.

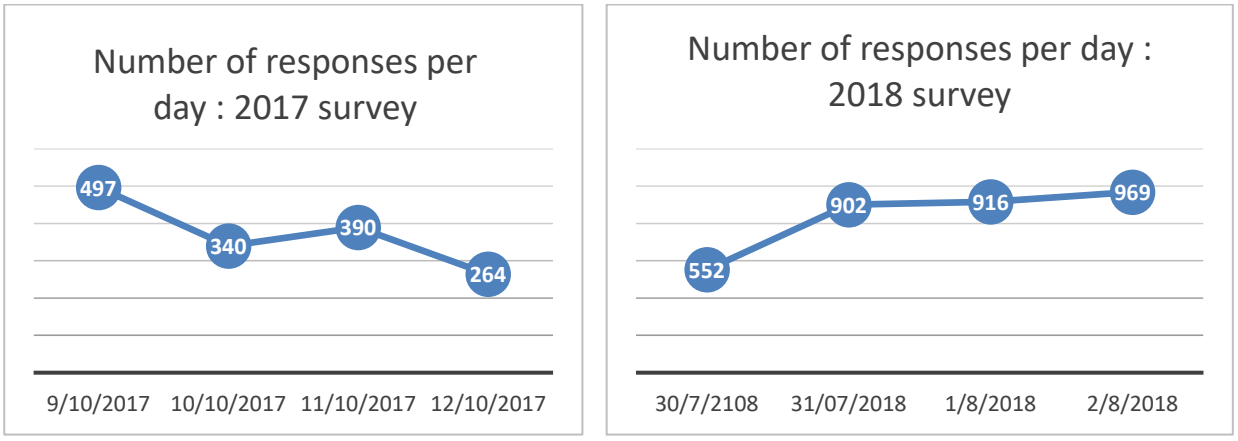


Figure 20: Survey completion dates with corresponding number of responses

The final sample sizes for the two surveys were 1 489 and 3 257 respectively. This includes a small number of surveys that were completed by the respondents after class hours in their own time. The required sample sizes for a 95% confidence level are 1061 and 1832 respectively (as calculated by the Sample Size Calculator in www.surveysystem.com/sscalc.htm). The actual sample sizes exceeded these values significantly. Interestingly, when performing the calculation for a 99% confidence level, sample sizes of 1832 and 1833 respectively were indicated. This showed that with the sample size of the first survey we can be 95% sure that the true population values would fall within the range of values obtained from the sample, and for the sample size of the second sample we can be 99% sure (Oates, 2006).

The same calculator was used to calculate the confidence intervals and they were 2.53 and 1.7 respectively. However, it is not possible to rely on these values since the sample is not genuinely random. This is because the respondents did not represent all the possible degree registrations at the university, and that all the respondents were from a single South African university.

4.3.2 Data collection

4.3.2.1 Survey method

The survey method employed was a web-based questionnaire. It was created and administered using Qualtrix. The aim of the survey was to gather data on the aspects in the IDT theory. The first two constructs, Personal data and Personal Influences, could be covered in the questionnaire. However, the last construct, Environmental context, could not be examined using close-ended questions. It was to be explored during the qualitative phase of the study.

4.3.2.2 Measurement

The questionnaire was created using the Individual Differences Theory of Gender and IT as underlying theoretical construct. Appendix A illustrates the theory constructs and the corresponding questions used.

The measurement scales used in examining the constructs of the theory, varied from simple Yes/No responses to 7-scale Likert scales. There were no open-ended questions posed in the online questionnaire. The questions and their measurement scales can be seen in Appendix B.

4.3.2.3 Pre-testing

The first version of the questionnaire was sent to the Department of Statistics for pre-testing. They approved the questions after requesting a layout of the relationship between the dependent and independent variables. The layout is illustrated in Table 17. The dependent variable is the degree for which the student is registered at the university. The independent variables are the various construct in the theory, amongst which are personal data and influencing factors.

Table 17: Variables used to investigate the relationship between the dependent and independent variables.

Dependent variable	Independent variables
Decision to choose IT major :	
Degree (STEM vs IT Degree)	**Personal data :**
	2.1 Gender 3.2 Ethnicity – cannot use 2.2 or 2.3 Nationality 3.13 Spouse / partner 3.14 Children 3.3 Family background 3.4 Family background – Father's education 3.5 Family background – Mother's education 3.6 Family background – Guardian's education 3.7 Family background – Father's employment 3.8 Family background – Mother's employment 3.9 Family background – Guardian's employment 3.10 Mother, housewife or working woman 3.12 Socio-economics- computer / own room / internet 4.1 School type 4.2 Subjects taken at school 4.6 and 4.7 IT / CAT taken at school? 4.3 Matric maths mark 4.4 Subject types at school 6.2 Personality traits 5.3 (1,2) Ease of use / happy to use computers 3.12 Exposure to computer at home 4.9 Access to computing at school 4.10 Work on computer at school 4.11 Access to computer lab at school 4.12 Work in computer lab at school 4.13 How used school computer 3.11 Salient referents – parents/guardians – encouragement 4.14 Role models and mentors – teachers / counsellors
	Shaping & Influencing factors
	5.1 + 5.2 Degree now registered for 4.1 School type 4.2 Subjects taken at school 4.5 and 4.6 IT / CAT
	Environmental context
	3.1 Home (City/rural)

Note: Certain questions did not form part of the eventual statistical analysis since they were dependent upon a previous answer and were therefore not posed to all the respondents. Examples are question 4.8 (IT subject enjoyment) and question 5.4 (reasons why NOT taking IT) which were only presented to students registered for a STEM degree,

and more specifically an IT degree. Other examples are questions 4.12 and 4.13 which were only asked of the students who had access to school computers.

The questionnaire was then pre-tested by seven Honours students. This happened during September 2017. The students were given a hard copy of the questionnaire and asked whether the questions were sensible and understandable, if any issues they deemed important have been omitted from the questionnaire, or if there was anything, in their opinion, that should be changed. The time it took for them to complete the survey was also recorded. Their feedback was that the questionnaire was too long and unfocused. Apart from the question whether the student took CAT and/or IT as an elective subject at school, the postgraduate students suggested that the questionnaire required an explicit question on whether the CAT and/or IT subjects were actually available to students at their school. Lastly, one male postgraduate student suggested that a question be added regarding gaming, since he was attracted to IT studies via his interest in computer gaming. The option was subsequently added to the question.

The researcher's supervisor, possessing many years of experience regarding factors that influence students' IT study choice, suggested including questions on the respondent's matric maths mark and their favourite matric subjects.

During the week before administration of the first questionnaire, six tutors piloted the questionnaire. Their feedback was that the questions were easy to understand, and most importantly, that the entire exercise took an average of 8 minutes to complete. The time it took was important since the survey had to fit in with the lecture schedule. When the AIM labs originally agreed to allow students to complete the questionnaire, a time limit of 10 minutes was agreed upon for survey completion.

The second survey was administered in 2018, and was piloted by seven tutors. Their feedback was similar to the feedback of the first group of tutors, and the survey was administered unchanged.

4.3.3 Data Analysis

Data analysis was performed using two software packages: the Excel spreadsheet software and the SPSS statistical software. As the survey was designed and administrated using the Qualtrix questionnaire service, the researcher was able to export the completed questionnaire data into various different formats. The Excel data format was used to first export the data to an Excel spreadsheet, where the data was cleaned. Then a .csv file was created and imported into the SPSS software for statistical analysis.

The dataset was cleaned by first removing the empty responses, where the respondents chose not to participate in the survey (where column Q1.1 = "No"). Then incomplete responses were removed, being those responses that had a completion rate of less than 98%. After perusal, eleven respondents' data for question number 5.3 of the 2017 survey data were seen to be incorrect due to multiple selections of Likert scale items. One respondent indicated that she was female, but also indicated that she attended a boy's-only school. These responses were deleted.

A number of responses were pre-tests performed by the staff of the computer laboratories where the survey was to be administrated. These test runs were performed by the lecturers who were invited to familiarise themselves with the questions in the survey before allowing the students to complete it. These test runs were also removed, being easy to detect since they were dated before the official survey start time.
To facilitate statistical analysis, the degree which each respondent had registered for, had to be classified into one of three types: IT related degrees, (other) STEM degrees and non-STEM degrees. To this end, the researcher inserted a column indicating the type of degree each student selected. It enabled statistical analysis of the data in terms of STEM degree and IT degree respondents. The type of degree was mainly determined by the university faculty it resorted under. STEM degrees are seen as those resorting under the faculties Engineering, Architecture and Health Sciences. This includes all IT-related degrees as well as BSc degrees. Non-STEM degrees are seen as those resorting under the social sciences and include qualifications such as BCom, BA, BDiv, BEd and LLB.

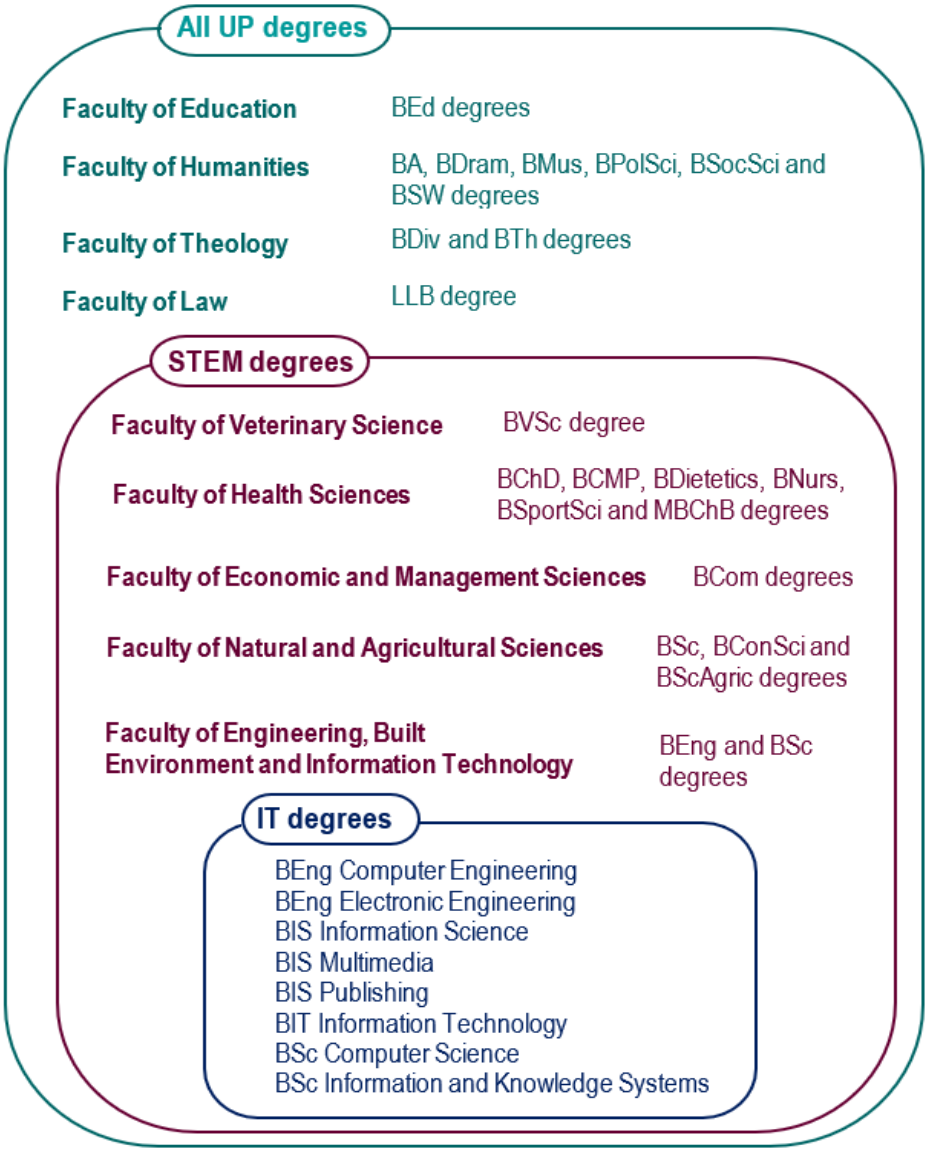


Figure 21: Degrees and corresponding faculties grouped according to Non-STEM, STEM and IT-related qualifications.

The data was subsequently sent to the Statistics Department where inconsistencies in the data itself was checked. Responses containing obvious inconsistencies were deleted. Table 18 contains details of the data cleaning for both years' surveys.

Table 18: Survey response information and number of respondents

	2017 IT Major Survey						2018 IT Major Survey					
Downloaded from Qualtrix	1 November 2017						4 September 2018					
Surveys started	1518						3289					
Surveys not completed & non-responses	43						47					
Surveys completed	1475						3242					
	Male			Female			Male			Female		
	501 (34%)			974 (66%)			1160 (35.8%)			2082 (64.2%)		
Degree types*	IT	STEM	Other	IT	STEM	Other	IT	STEM	Other	IT	STEM	Other
	31	193	277	24	315	635	98	452	610	61	731	1290
	6%	38.5%	55%	2.5%	32%	65%	8%	39%	53%	3%	35%	62%

*__Degree types__ indicate the type of degree the student had registered for at the university. For the purposes of this study, all the degrees offered by the university have been grouped into three types: IT-related degrees, STEM degrees (excluding IT-related degrees) and other degrees. The names of these degrees are listed in Figure 21: Degrees and corresponding faculties grouped according to Non-STEM, STEM and IT-related qualifications..

This concludes the description of the quantitative phase of data collection of this study. The qualitative phase of data collection flows from this basis, and is described next.

4.4 PHASE 2 DATA COLLECTION – QUALITATIVE PHASE

The approach to sampling, data collection and data analysis is now described, as performed for the second phase of the study.

4.4.1 Sampling method

4.4.1.1 Target population

The target population for the qualitative phase consisted of all the female questionnaire respondents who indicated their willingness to participate in a follow-up interview. The numbers comprised 233 according to the first questionnaire administration and 622 according to the second questionnaire administration. Since there were so few female Information Technology students, those of both genders were invited to the focus groups. The degree group BAdmin was omitted from this study since their entrance requirements did not include mathematics, which forms a key subject for any IT studies.

4.4.1.2 Sampling method

The sampling method used in the second (qualitative) phase was probabilistic stratified sampling. The follow-up group of respondents were comprised of individuals from the first phase who had agreed to a follow-up interview and had supplied an email address or telephone number for that purpose. Respondents were grouped according to the degree they were registered for, and were invited to an interview during a specific time slot. It was believed that individuals from each faculty would respond similarly to the open-ended questions posed, and sorting the focus group respondents into their faculties would best help explain the quantitative results.

The sample method included grouping the potential interview participants into STEM and Non-STEM degrees according to their registration data. The STEM groups were the IT degrees (from different faculties), as well as the BSc, Architecture and Health Sciences (including Veterinary Sciences) groups. The Engineering degree group were not

represented in the data as they were exempted from the AIM module, where the survey was administered. The Non-STEM groups were identified as BCom, BA, BDiv, BEd and LLB.

It was decided to forego interviewing respondents from the faculties of Education, Health Sciences, Law and Theology as they were either on a different campus or were too few in numbers. Only the female students from the faculties Humanities, Economics and Management Sciences, Engineering, Built Environment and Information Technology and Natural and Agricultural Sciences were considered for the interviews. The respondents studying IT degrees were grouped together in a fifth interview group.

Therefore the faculties included in invitations were:

- Faculty of Economic and Management Sciences
- Faculty of Engineering, Built Environment and Information Technology
- Faculty of Humanities
- Faculty of Natural and Agricultural Sciences

The faculties excluded from interview invites were:

- Faculty of Education
- Faculty of Health Sciences
- Faculty of Law
- Faculty of Theology
- Faculty of Veterinary Science

For the purposes of this study, the IT degrees were seen as the following degrees:

Faculty	Degree
• Faculty of Natural and Agricultural Sciences	• BSc Geoinformatics
• Faculty of Economic and Management Sciences	• BCom Informatics Information Systems
• Faculty of Engineering, Built Environment and Information Technology	• BIS Information Science • BIS Multimedia • BIS Publishing

- BIT Information Technology
- BSc Computer Science
- BSc Information and Knowledge Systems
- BEng Computer Engineering
- BEng Computer Engineering ENGAGE

The focus group sizes were planned to be between 4 and 8 participants. However an extremely low response rate was achieved and only two or three students per faculty group replied to the invitations. There were a number of reasons for this, most of which only became apparent after the interviews had been performed. First and foremost was the busy schedule of the students. Only one possible time slot was provided for each group. Although the time slot was purposefully set over lunch time, many students nevertheless had to attend class. Secondly, the invitation was sent to the student's university email address. Since students primarily use their personal email addresses, they hardly check their university mailboxes - in so doing missing the message. Another influencing factor was that the 2017 survey respondents had already forgotten about the survey and about agreeing to participate in focus groups, because an entire year had passed before they received the invitation. The participants invited to the second set of focus groups were those who volunteered their contact information in the 2018 questionnaire administration. The response rate was slightly better because the survey was still fresh in their minds.

According to the types of degrees, five groups of respondents were invited to interviews, from 2017 and 2018 respondents respectively:

- Females from Faculty of Humanities
- Females from Faculty of Economic and Management Sciences
- Females from Faculty of Engineering, Built Environment and Information Technology
- Females from Faculty of Natural and Agricultural Sciences
- Females studying IT degrees (from all faculties)

Due to the low number of replies to the invitations, the researcher requested the participants to bring along a friend who was studying towards the same degree. This meant that there were a few males among the mostly female participants. The focus group sizes were intended to be at most 8 participants each, but in practice the interviews were mostly

individual interviews with only two focus groups which comprised 3 participants each. The number of respondents initially invited together with the number of respondents eventually interviewed, are listed in Table 19.

Table 19: Interview response rates

	Respondents Invited		Respondents Interviewed	
Summary	2017	2018	2017	2018
HUM (Humanities)	60	145	0	3*
EMS (Economic and Management Sciences)	51	172	3	2
EBIT (Engineering, Built Environment and IT)	5	39	0	2*
NAS (Natural and Agricultural Sciences)	73	197	2	1
IT degrees (from Commerce faculties and School of IT)	44	69	2	6

*Numbers include pilot study students

The actual interview dates and participant numbers can be seen in Table 20.

Table 20: Interview dates

Friday 24 August 9:30 Pilot Group : EBIT (Engineering) and HUM (Development Studies)	
Wednesday 29 Aug 11:30 Group 1 HUM 2017 Wednesday 29 Aug 12:30 Group 2 EMS 2017 Wednesday 29 Aug 13:30 Group 3 EBIT 2017 Thursday 30 Aug 11:30 Group 4 NAS 2017 Thursday 30 Aug 12:30 Group 5 IT 2017	Wednesday 12 Sept 11:30 Group 6 HUM 2018 Wednesday 12 Sept 12:30 Group 7 EMS 2018 Thursday 13 Sept 11:30 Group 8 EBIT 2018 Thursday 13 Sept 12:30 Group 9 NAS 2018 Friday 14 Sept 12:30 Group 10 IT 2018
17 October 2018 IT students : (IT-6) and 18 October 2018 (IT-7 and IT-8)	

4.4.1.3 Sample size

Upon concluding the interviews, a total of 21 students were interviewed, of which 5 were male and 16 female students. Table 21 shows their faculty grouping.

Table 21: Interviewee numbers per faculty

Grouping	Faculty	Male	Female	Total
Non-STEM	EMS	1	4	5
	HUM		3	3
STEM	EBIT		2	2
	NAS		3	3
IT	EBIT and EMS	4	4	8
	Total	5	16	21

The largest number of students interviewed, were the IT students, who hailed from both the EBIT and EMS faculties. The reason for this is that different IT degrees are presented in each of the EBIT and EMS faculties.

Table 22 provides a short summary of the respondents according to faculty, degree, gender, ethnicity and year of study. The combination of the first two columns are used to refer to each respondent. As an example, the first respondent who studies an IT degree will be referred to as IT-1.

Table 22: Interview Respondent Key

Faculty	#	Group	Survey Year	Degree enrolled	Gender	Ethnicity	Study Year
EBIT	P	Pilot	-	Engineering	F	Black African	3
HUM	P	Pilot	-	Development Studies	F	Black African	Hons
HUM	1	6	2018	BA General	F	Black African	1
	2	6	2018	BA Social work	F	Black African	1
EMS	1	2	2017	BCom Accounting Sciences	F	Black African	2
	2	2	2017	BCom Accounting Sciences	F	Black African	2
	3	2	2017	BCom	M	Black African	2
	4	7	2018	BCom Financial Sciences	F	Black African	1
	5	7	2018	BCom Financial Sciences	F	Black African	1
EBIT	1	8	2018	BSc Quantity Surveying	F	Black African	1
NAS	1	4	2017	BSc Agric Animal Science	F	White	1
	2	4	2017	BSc Biochemistry	F	Black African	1
	3	9	2018	BSc Medical Sciences	F	Black African	1
IT	1	5	2017	BCom Informatics Information Systems	M	White	1
	2	5	2017	BCom Informatics Information Systems	M	Black African	1
	3	10	2018	BIS Multimedia	F	Black African	1
	4	10	2018	BSc Information & Knowledge Systems	M	White	1
	5	10	2018	BIT Information Technology	M	Black African	1
	6	-	2018	BCom Informatics Information Systems	F	Black African	1
	7	-	2018	BCom Informatics Information Systems	F	Black African	1
	8	-	2018	BCom Informatics Information Systems	F	Black African	1

4.4.2 Data collection

4.4.2.1 Survey method

Focus group interviews were planned, but due to the students' busy schedule, only two focus groups were conducted with three participants each. The other groups consisted of two students and a number of interviews were one-on-one.

4.4.2.2 Measurement

The interviews and focus groups were conducted according to the three main constructs of the IT Study Choice Framework: Personal data, Shaping and influencing factors and Environmental context (See Figure 22: IT Study Choice Framework, which is repeated from Chapter 3 for the reader's convenience).

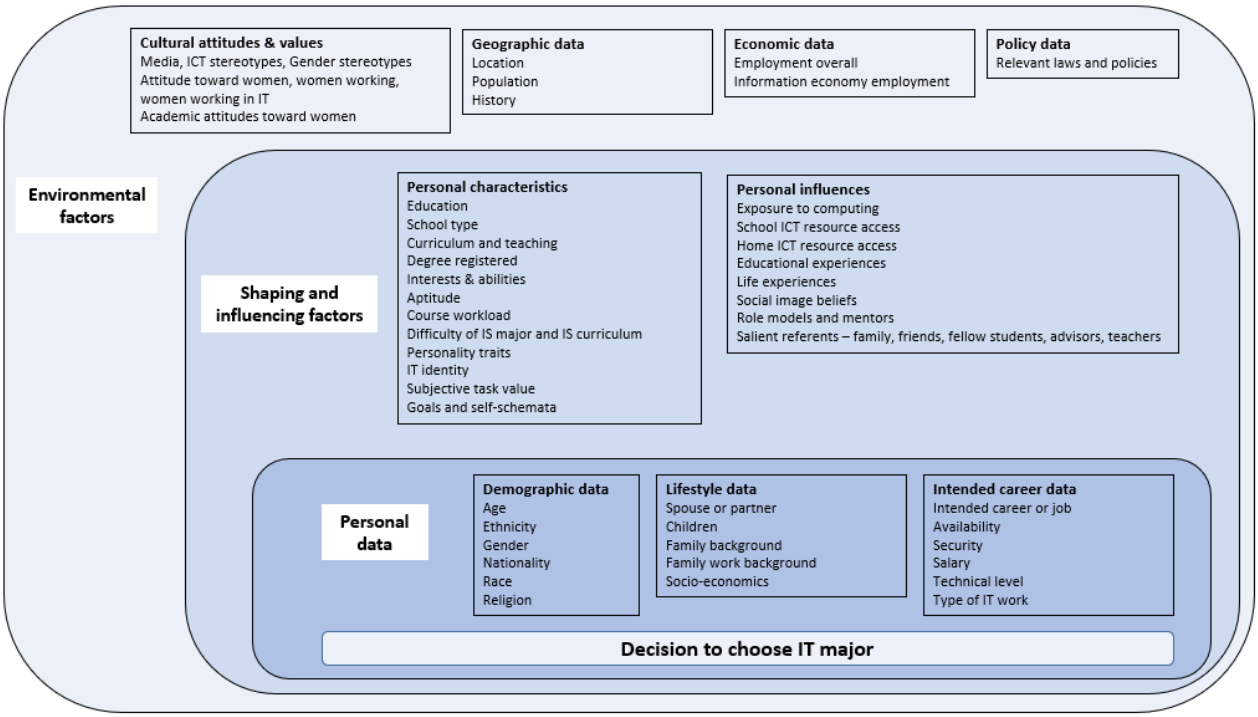


Figure 22: IT Study Choice Framework

The IT Study Choice Framework consists of three layers of influence: the first level, "Personal data", describes the physical environment in which the individual finds himself. This includes factors such as demographics and information on the person's family history. It also contains information on the individual's intended career. The second layer of factors, "Shaping and influencing factors", pertain to the individual's personal preferences and experiences, and also influences from those people close to him. The outside layer, "Environmental context", consists of environmental factors that the individual has no control over, but which form the ecosystem inside which the individual has to function.

The interviews were completely open-ended in that an A3 representation of the IDT (Appendix D) was put up against the wall and the students were requested to refer to it throughout, as an aid to recalling aspects that influenced them personally in their study choice.

4.4.2.3 Pre-testing

A pre-test focus group was conducted where two students were invited to a discussion and two honours students assessed the focus group interaction. It was found that the open-ended questions stimulated personal feedback, and that recording the process on tablet or cell phone was sufficient to capture the content of the discussion.

4.4.3 Data Analysis

The focus group and interview discussions were captured and saved in voice files and then transcribed in Word. Thematic analysis was performed in Excel, according to the constructs of the IDT theory. Any issues outside of the IDT constructs were recorded at the bottom of the spreadsheet as emergent aspects.

4.5 PHASE 3 DATA COLLECTION – QUALITATIVE PHASE

The approach to sampling, data collection and data analysis is now described, as performed for the third phase of the study.

4.5.1 Sampling method

4.5.1.1 Target population

The target population for the third phase consisted of all the first-year students of the year 2018 who were registered for the INF112 module.

4.5.1.2 Sampling method

A convenience sampling method was used. The respondents were comprised of first-year students who were registered for an introductory informatics module.

4.5.1.3 Sample size

A total of 253 students handed in their completed questionnaires, of which 107 were male and 143 were female students. Table 23: Interviewee numbers per faculty shows their faculty grouping.

Table 23: Interviewee numbers per faculty

Faculty	Male	Female	Other
BCom Accounting Sciences	31	50	
BCom Financial Sciences	17	40	1
BCom (General)	13	20	1
BCom Informatics	13	7	
BCom Business Management	8	5	
BCom Economic and Management Sciences	3	1	
BCom Own Choice	1	4	
BCom Investment Management	4	2	
BCom Supply Chain Management	5	2	
BIS Information Science	8	4	1
BSc GeoInformatics	3	5	
BSc Geography	1	3	
	107	143	3
Total			253

The largest number of students hailed from the EMS faculty. Most students were registered for BCom Accounting Sciences, followed by BCom Financial Sciences, BCom (General), BCom Informatics and BCom Business Management. The largest percentage of respondents were registered for commerce degrees, which include a number of compulsory

informatics modules. A total of 25 respondents were registered for BIS Information Science, BSc GeoInformatics and BSc Geography respectively.

4.5.2 Data collection

4.5.2.1 Survey method

A one-page questionnaire (Appendix E) was handed out to students in class. The questionnaire was based on the main aspects that emerged from the interviews (phase 2), being that secondary school students are unaware of the variety of careers in IT. They are also intimidated by the perceived difficulty of the subject, and many were not exposed to the subject IT at school. The last question was aimed at gathering their ideas on best ways of attracting young students to IT careers.

4.5.2.2 Measurement

The questionnaire contained two demographic and four open-ended questions. The student's enrolled major is first ascertained, they were then asked to list the factors that led to their decision. The last three questions pertain to IT – whether they took it at school, whether they knew about available careers in IT, and whether they have any suggestions to how more young people could be attracted to IT.

Please enter the degree you are registered for, e.g. BCom Accounting Sciences and indicate male / female
Question 1 :
We would like to know how you chose to study this degree. Think of anything that influenced you – the media, available jobs, family, friends, your own interests, etc.
Question 2 :
If your school had offered the subject Information Technology (IT), would you have taken it? Please explain your answer.
Question 3 :

When you were at school, did you know about available studies or careers in Information Technology ?
Question 4 :
How do you think more people can be attracted to jobs in IT?

4.5.2.3 Pre-testing

A pre-test was conducted by presenting the questionnaire to four assistant lecturers who were also honours students. They approved the questionnaire, confirming that it is short enough to be completed within 10 minutes, and open-ended in order to encourage original replies.

4.5.3 Data Analysis

The handwritten documents were transferred to digital format by typing the replies into MS Excel. Content analysis was performed according to the process described in Erlingsson and Brysiewicz (2017). The replies to each question were first condensed and coded, then categorised and finally assigned overarching themes.

4.6 DATA INTEGRATION

Integration of the three datasets was done after analysing the data of each phase. The data was integrated using a joint display with the IT Study Choice Framework as the underlying theory. The salient responses from each phase were summarised in a side-by-side display (Guetterman et al., 2015).

4.7 ETHICS

Ethical research behaviour requires that the researcher informs participants of the purpose of the study, demonstrating reciprocity of information and ensuring participants' privacy. To

ensure adherence to the necessary ethical standards, every researcher applies for institutional ethical clearance of his/her proposed project. The approval documents are listed in Appendix C.

The researcher informed the participants of the purpose of the study during both phases of the study. The first phase required that the participant complete a questionnaire, of which the first page included a description of the study and ensured privacy of response. The second phase of the study entailed interviews and focus groups. At the start of each session, the purpose of the study was explained to participants, together with an assurance that their privacy would be ensured. The researcher also informed them that the results of the study will be published and attempted to gain their cooperation by illustrating the advantages of them sharing their experiences. Reciprocity was demonstrated by the researcher offering to supply the students with a copy of the research write-up provided they sent a request for it together with their email address.

4.8 CONCLUSION

This chapter describes the philosophical underpinning of the study as well as the study design. Using a mixed methods design allowed the researcher to pursue a pragmatist approach. Data collection was based on a theory proven to be relevant to investigating gender and IT phenomena. Two surveys were conducted using a questionnaire based on the identified theory. Participants willing to participate in follow-up discussions were invited to focus groups, where they elaborated on the factors that lead to their choice of major, while situating their discussions inside the same gender and IT theoretical framework. A final phase was conducted, focusing on practical avenues of addressing the shortage of female students pursuing IT majors.

5 ANALYSIS OF FINDINGS

5.1 INTRODUCTION

The previous chapter described how the data was generated and recorded. This chapter describes the findings of each phase in turn. The findings of each phase are then integrated into a cross-phase joint display. At the end of the chapter, the findings are applied to the IT Study Choice Framework and graphically presented.

The chapter map can be seen in Figure 23: Analysis of Findings Chapter Map.

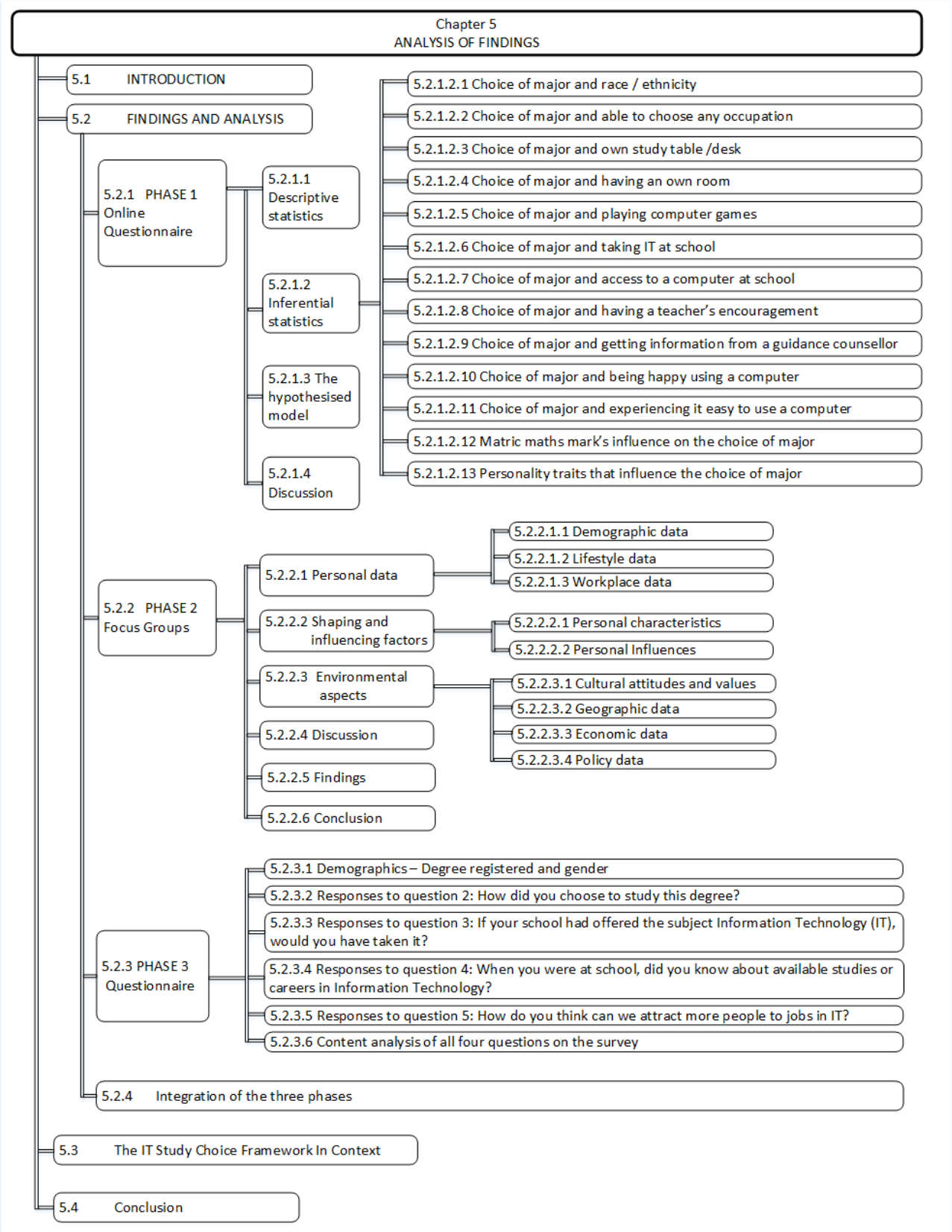


Figure 23: Analysis of Findings Chapter Map

5.2 FINDINGS AND ANALYSIS

5.2.1 Phase 1 – Online Questionnaire

The first phase of data collection consisted of an online questionnaire administered to a cohort of (mainly) first-year students. The exercise was repeated the following year, resulting in two datasets: one for the University's 2017 student intake, and one for the 2018 student intake.

5.2.1.1 Descriptive Statistics

Table 24: Population demographics lists three demographic aspects of the respondents: their gender distribution, their current year of study, and the provinces where they (the South African respondents) live.

Table 24: Population demographics

		2017 Survey	%	2018 Survey	%
Gender	Males	501	33.9	1155	35.8
	Females	968	66	2076	64.2
	Other	6	0.5	11	0.3
Year of study	First Year	1190	80.7	3 082	95.1
	Second Year	242	16.4	108	3.3
	Third Year	33	2.2	35	1.1
	Fourth Year	10	0.7	17	0.5
Province	Eastern Cape	36	2.6	93	2.9
	Free State	26	1.9	69	2.2
	Gauteng	781	56.8	1721	54.2
	KwaZulu-Natal	141	10.2	290	9.1
	Limpopo	163	11.8	429	13.5
	Mpumalanga	160	11.6	365	11.5
	North West	47	3.4	147	4.6
	Northern Cape	3	0.2	17	0.5
	Western Cape	19	1.4	44	1.4
	No response	99	7	67	2.1

The majority of respondents are first-year students (see Table 24: Population demographics) from the Gauteng province of South Africa. This is the most economically productive province of the country and contains the city of Pretoria, which is the administrative capital of the country. This study was performed at the University of Pretoria, geographically explaining the fact that most students hail from the province Gauteng (see Figure 24: South African students' home provinces). Figures 24 and 25 show where the students spent their childhood (cities or rural areas) and what language they spoke at home.

According to Statistics South Africa (Statistics South Africa, 2019), there are four major population groups in South Africa: Black Africans, Coloured, Indian and/or Asian, and White people. Black Africans consist of mainly four ethnic groups - Nguni, Sotho, Shangaan-Tsonga and Venda. These ethnic groups have many subgroups, the largest of which are the Zulu and Xhosa groups.

The White population is mainly of British or European descent, while the coloured population have a mixed lineage. They comprise European genes combined with indigenous Khoisan genes or those of African slaves that were brought in from all over the continent. The Indian/Asian population group represents descendants of slaves or indentured labourers from India who were brought into the country during the 19th century by the British. This document uses the same population classification and naming as used by Statistics South Africa.

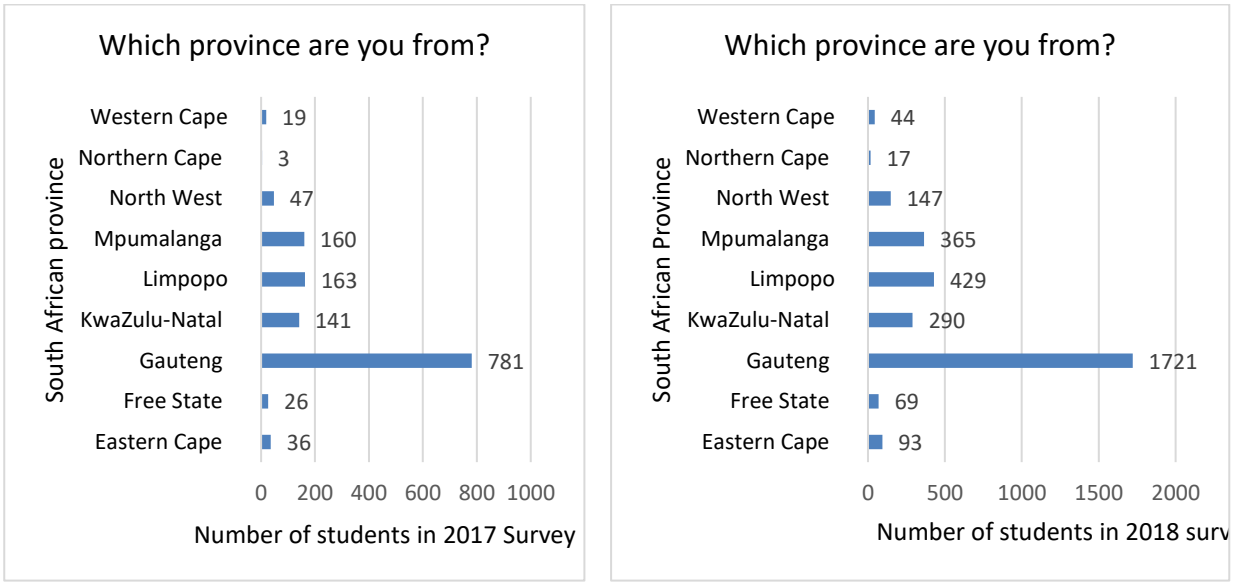


Figure 24: South African students' home provinces

Further demographic data was available in terms of the students' childhood home (Figure 25) as well as home language spoken (Figure 26).

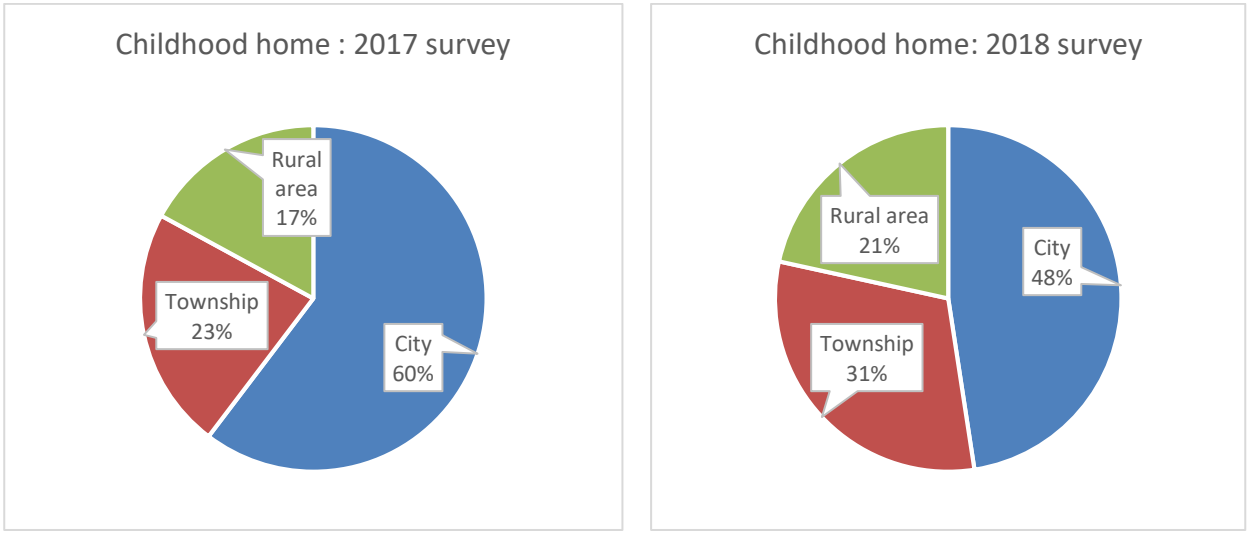


Figure 25: Locations of respondents' childhood homes

Most respondents hail from cities and townships (economically disadvantaged settlements) and only a fifth come from rural areas.

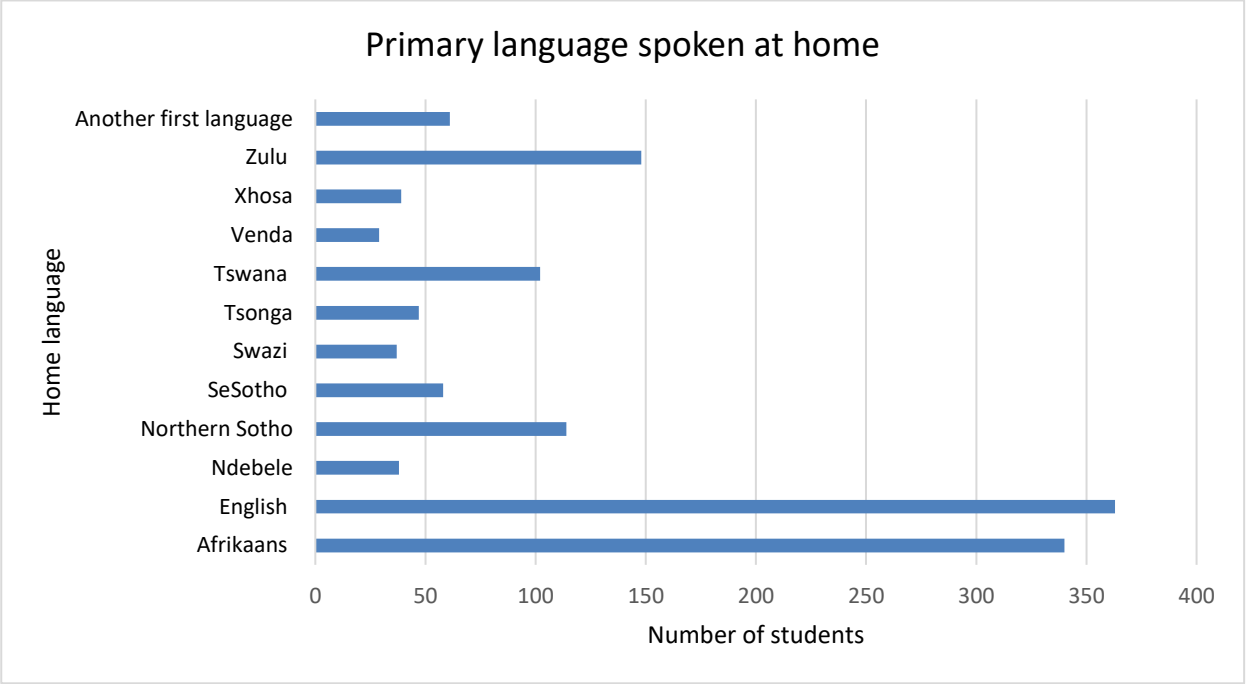


Figure 26: Primary language spoken at respondents' childhood homes (only 2017 data available)

A pertinent aspect of the reported home language of the respondents is that the majority of students indicated that they speak English as their home language. The fact that the young people indicate English as their home language could be linked to increasing urbanisation (Naidoo, 2018). Another interesting demographic is the fact that while most respondents report that they come from a household headed by both parents, a large number report that they come from a single-parent household, and more specifically that it is their mother heading the household. In the case of Asian students there are no reported female-headed households, in the case of Indian and White students the number of female-headed households is less than a quarter of a two-parent household, and in the case of Coloured students it is half. However, in the case of African students the numbers from a two-parent and single-parent household, are almost equal. Figure 27 shows that there are almost as many female-headed households as there are two-parent households in the African student community.

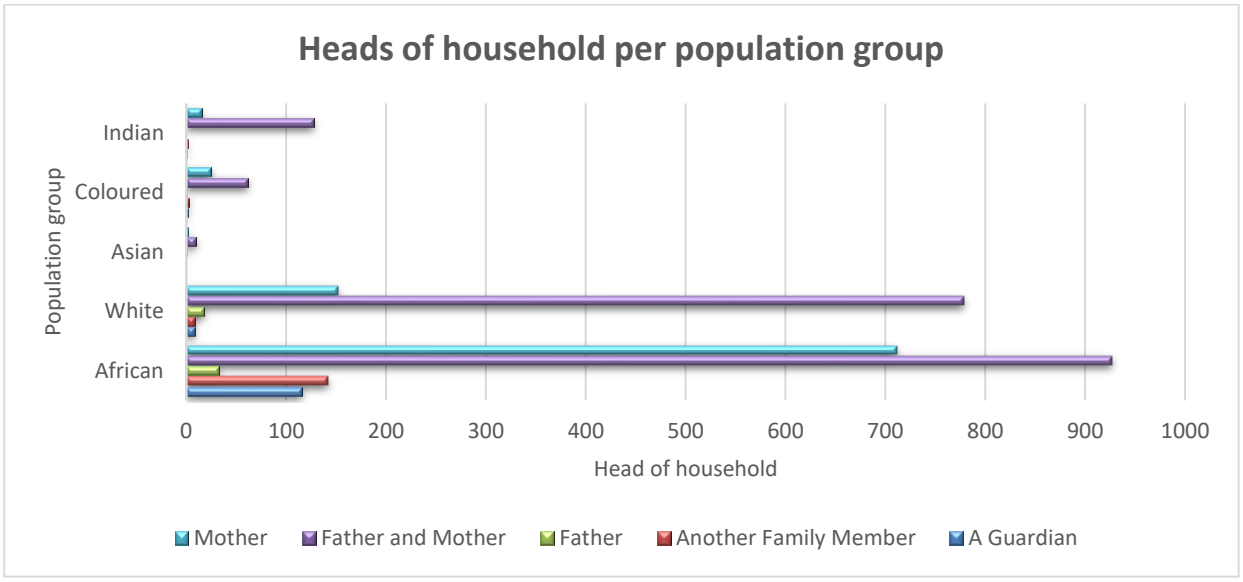


Figure 27: Heads of households

An important demographic indicator is the number of students whose parents do not have any postsecondary education experience. Contrasted to continuing-generation college students (CGS), these first-generation students (FGS) differ markedly in terms of household income, parental support and academic success (Redford & Hoyer, 2017). Figure 27 shows that the 2018 survey respondents consisted of twice as many female continuing-generation students as female first-generation students, while there was a very small number of male first-generation students.

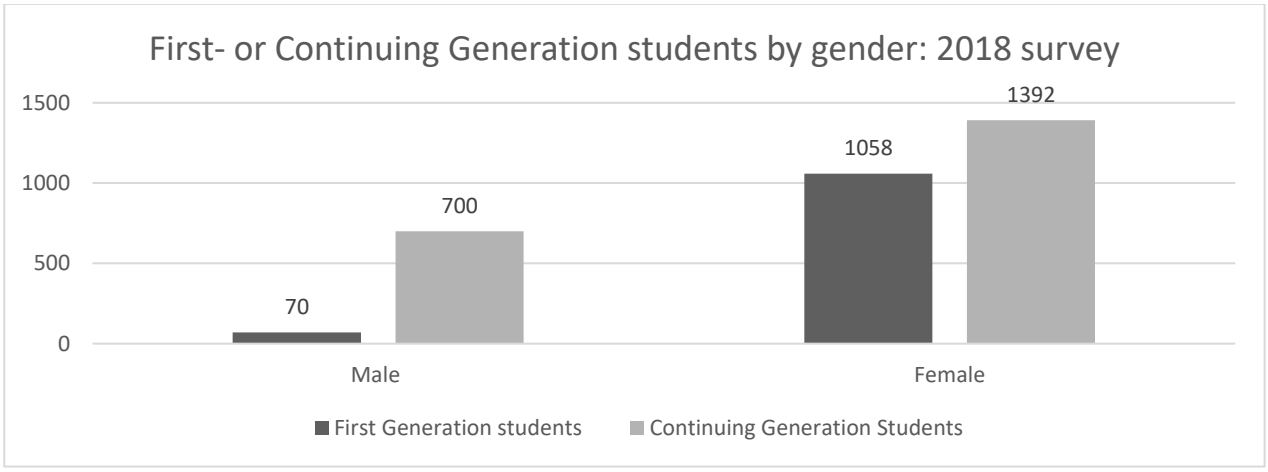


Figure 28: Number of first-generation students and continuing-generation students in the 2018 survey.

Table 25 lists the variables available in this study that can be used to determine whether any relationships exist between the dependent and independent variables. The dependent variable is the degree for which the student is registered. It was decided to statistically examine and contrast the responses of the students registered for STEM degrees versus those registered for IT degrees. This was possible since each respondent had indicated what degree they were registered for. The researcher had added a column to the survey results indicating whether the degree was an IT-related degree, a STEM degree or a degree which was neither of the two. A STEM degree in the context of this study is any STEM degree but **excluding** all IT-related degrees.

Table 25: Variables used to determine relationship between dependent variable and independent variable.

Dependent variable	Independent variables
Decision to choose major	
	Personal data
5.1 & 5.2 Degree now registered for (**STEM or IT Degree**)	2.1 Gender 2.3 Ethnicity 3.3 Family Background 3.4 Family Background – Father's education 3.5 Family Background – Mother's education 3.6 Family Background – Guardian's education 3.7 Family Background – Father's employment 3.8 Family Background – Mother's employment 3.9 Family Background – Guardian's employment 3.10 Mother housewife or working woman 3.11 My father/ mother/ guardian encouraged me to do well at school & My father / mother / guardian encouraged me to choose any occupation I liked 3.12 Socio-economics- computer / internet / own room / own study table 6. Personality traits (Ten Item Personality Index)
	Shaping & Influencing factors
	4.1 – School type 4.3 (2017) / 4.4 (2018) - Matric mark for mathematics 4.5 & 4.6 – Take school subject IT / CAT 4.11 My teacher encouraged me to do well at mathematics / IT & My guidance counsellor helped me in my university study choice / told me about IT work possibilities 5.3 I am happy using a computer in my work or studies & It is easy for me to use a computer for work or play
	Environmental context
	3.1 Home (City/rural)

5.2.1.2 Inferential Statistics

The survey contained a variety of question types, which necessitated using different statistical approaches:

- The associations between the categorical independent variables (such as gender and ethnicity) and the dependent variable were determined with Chi-square/ Fisher exact tests.
- The non-parametric Wilcoxon test was used to test the distribution of scores for continuous independent variables such as the maths and personality scores.
- Lastly the z-test of proportion was performed for multiple choice questions.

The categorical independent variables are first discussed. This is followed by the continuous independent variables, the matric maths mark and the personality test values.

Despite the large number of responses received in both surveys, the number of females taking IT-related degrees remain so small (24 females in the 2017 survey and 61 in the 2018 survey – see Table 1) that it was necessary to forego using the Chi square test. Fisher's Exact Test was used to calculate the strength of relationships between variables.

Convention dictates that the null hypothesis is assumed at the outset, meaning that it is assumed that no relationship exists between the two variables. Only when a p-value of less than 0.05 is calculated, can it be assumed that a relationship exists between the two variables. The p-values of Fisher's Exact Test between the dependent and independent variables are listed in Table 26, according to male and female respondents and for both the 2017 and the 2018 surveys. A description of the finding is provided where the p-value indicates that a relationship exists. To improve readability, statistically significant values are highlighted in the tables. In some cases where no significant relationship exists between the STEM and IT students within gender, the data is aggregated and discussed across genders and/or study field.

Table 26: Summary of relationships between variables according to gender and distinguishing between STEM and IT majors.

Dep Var		Independent variable	Fisher's exact test				
			2017 survey		2018 survey		
			M	F	M	F	Finding
Degree (STEM or IT)	2.3	Which race / ethnicity best describes you?	This question was not asked in the 2017 survey		0.1454	0.0085	SR* for 2018 females
	3.3	Who mainly looked after you in your childhood home?	0.3834	0.8996	0.0960	0.4272	No SR
	3.4	Which education type best describes your father's education?	0.5081	0.3353	0.6591	0.6344	No SR
	3.5	Which education type best describes your mother's education?	0.4967	0.6558	0.0785	0.6387	No SR
	3.7	Which employment type best describes your father's employment?	0.2108	0.3261	1.0000	0.8022	No SR
	3.8	Which employment type describes your mother's employment?	1.0000	0.3561	0.1583	0.1583	No SR
	3.10.1	My mother was a housewife	0.5011	0.6416	1.0000	0.2302	No SR
	3.10.2	My mother was a professional working woman	0.8148	1.0000	0.2950	0.1111	No SR
	3.11.3	My father/ mother/ guardian encouraged me to do well at school	1.000	1.000	1.0000	0.1762	No SR
	3.11.4	My father / mother / guardian encouraged me to choose any occupation I liked	0.3226	0.0365	1.0000	0.1523	SR for 2017 females
	3.12.1	Did you have a computer at home?	0.6834	0.3130	0.0918	0.1008	No SR
	3.12.2	Did you have an internet connection at home?	1.000	0.3808	0.5732	0.3961	No SR
	3.12.4	Did you have a study table or desk you could use yourself?	0.8257	0.1821	0.6065	0.0107	SR for 2018 females
	3.12.5	Did you have your own room?	1.0000	0.4402	0.1844	0.0024	SR for 2018 females
	3.12.3	Did you work on the computer at home?	0.4356	0.1159	0.0503	1.0000	No SR
	3.12.6	Did you play computer games at home?	0.0823	0.2901	0.0015	0.3127	SR for 2018 males
	4.5.1	Did your school offer the	0.2454	0.3929	0.9110	0.4231	No SR

		subject Information Technology (IT)?					
	4.5.2	Did your school offer the subject Computer Applications Technology?	0.3351	0.8230	0.5031	0.5742	No SR
	4.6	Did you take the subject Information Technology (IT)?	0.0006	<.0001	<.0001	<.0001	SR
	4.9	Did you have access to a computer at school?	0.1003	0.7960	0.0052	0.4232	SR for 2018 males
	4.11.1	My teacher encouraged me to do well at mathematics	0.1602	0.0619	0.1540	0.7093	No SR
	4.11.2	My teacher encouraged me to do well at IT	0.0405	0.0110	0.0019	0.0087	SR
	4.11.3	My guidance counsellor helped me in my university study choice	0.4605	0.8674	0.3127	1.0000	No SR
	4.11.4	My guidance counsellor told me about IT work possibilities	0.0391	0.1742	0.0247	0.0947	SR for males
	5.3.1	I am happy using a computer in my work or studies	0.0590	0.0831	0.0587	0.0018	SR for 2018 females
	5.3.2	It is easy for me to use a computer for work or play	0.0299	0.4720	0.0005	0.0333	No SR for 2017 females
	5.3.5	I believe women in IT are just as effective as men in IT	0.5800	0.4122	0.6138	0.0977	No SR

Key :
SR – Significant Relationship
STEM students – Those students registered for a STEM degree, but excluding those students registered for an IT degree
IT students – Those students registered for an IT-related degree

As indicated in Table 26, the following variables were found to have a significant relationship (Fischer's Exact Test Two-sided Pr<=0.05):

- Choice of major (IT/STEM) and race / ethnicity
- Choice of major (IT/STEM) and having the freedom to choose any occupation.
- Choice of major (IT/STEM) and having an own study table or desk.
- Choice of major (IT/STEM) and having an own room.
- Choice of major (IT/STEM) and playing computer games at home.
- Choice of major (IT/STEM) and taking the subject Information Technology (IT) at school.
- Choice of major (IT/STEM) and having access to a computer at school.

- Choice of major (IT/STEM) and having a teacher's encouragement to do well at IT.
- Choice of major (IT/STEM) and getting information from a guidance counsellor about IT work possibilities.
- Choice of major (IT/STEM) and being happy using a computer in work or studies.
- Choice of major (IT/STEM) and experiencing it as easy to use a computer for work or play.

These relationships are presented in the form of contingency tables in the following sections (5.2.1.2.1 to 5.2.1.2.11), and the results are discussed. All frequencies are supplied in the contingency tables, but row and/or column frequencies are provided only for the statistically significant relationships.

5.2.1.2.1 *Choice of major (IT/STEM) and race / ethnicity*

There appears to be a significant relationship between the choice of STEM or IT major and the ethnicity of the 2018 survey's female students. Almost double the amount of African and Asian female students (9.3% and 11.5%) chose IT over STEM, while only 3.8% of White females chose IT (See the Row % in the table). There is no significant relationship among male students, but the numbers show that there were at least twice as many males as females choosing STEM over IT.

Question 2.3 Which race / ethnicity best describes you?							
		Males 2018			Females 2018		
Ethnicity		STEM	IT	Total	STEM	IT	Total
African	This question was not asked in the 2017 survey	257 56.85 79.81	65 66.32 20.18	322	427 58.41 90.65	44 72.13 9.3	471
White, Other		156 34.51 86.66	24 24.48 13.33	180	250 34.19 96.15	10 16.39 3.8	260
Asian, Coloured, Indian		39 8.62 81.25	9 9.18 18.75	48	54 7.39 88.5	7 11.48 11.5	61
Total		452	98	550	731	61	792
Two-sided Pr <= P				0.1454			0.0085

Numbers represent Frequency, Column %, Row %.

5.2.1.2.2 *Choice of major (IT/STEM) and having the freedom to choose any occupation*.

A statistically significant relationship was found in one group of respondents: the female students in the 2017 survey. More STEM students (95%) were encouraged to choose any occupation they liked than the IT students (83%).

Question 3.11.4 My father / mother / guardian encouraged me to choose any occupation I liked												
	Males 2017			Females 2017			Males 2018			Females 2018		
Degree	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total
Agree	173	30	203	300 93.7 95.2	20 6.2 83.3	320	402	173	30	203	300	20
Disagree	20	1	21	15 78.9 4.7	4 21.1 16.6	19	50	20	1	21	15	66
Total	193	31	224	315	24	339	452	98	550	731	61	792
Two-sided Pr <= P			0.3226			0.0365			1.0000			0.1523

Numbers represent Frequency, Row %, Column %.

5.2.1.2.3 Choice of major (IT/STEM) and having an own study table or desk.

A statistically significant relationship was found in one group of respondents: the female students in the 2018 survey. More STEM female students (79%) had their own study table at home than did female IT students (64%).

Question 3.12.4 Did you have a study table or desk you could use yourself?												
	Males 2017			Females 2017			Males 2018			Females 2018		
Degree	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total
Yes	143	24	167	258	17	275	343	72	415	575 93.6 78.7	39 6.4 63.9	614
No	50	7	57	57	7	64	109	26	135	156 87.6 21.3	22 12.4 36	178
Total	193	31	224	315	24	339	339	452	98	731	61	792
Two-sided Pr <= P			0.8257			0.1821			0.6065			0.0107

Numbers represent Frequency, Row %, Column %.

5.2.1.2.4 Choice of major (IT/STEM) and having an own room.

In the 2018 survey, there was a significant relationship between the female STEM and IT students. There were less female IT students (56%) who had their own room at home than did female STEM students (75%).

Question 3.12.5 Did you have your own room?												
	Males 2017			Females 2017			Males 2018			Females 2018		
Degree	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total
Yes	142	23	165	248	17	265	344 76.11	81 82.65	425	545 94.1 74.56	34 5.9 55.74	579
No	51	8	59	67	7	24	108 23.89	17 17.35	125	186 87.3 25.44	27 12.7 44.26	213
Total	193	31	224	315	24	339	452	98	550	731	61	792
Two-sided Pr <= P			1.0000			0.4402			0.1844			0.0024

Numbers represent Frequency, Row %, Column %.

5.2.1.2.5 Choice of major (IT/STEM) and playing computer games at home.

In the 2018 survey, there was a significant relationship between the male STEM and IT students. More IT students played computer games at home than STEM students (89% vs 72%). Looking at it the other way around, only 10% of IT students did *not* play computer games at home compared to almost 30% of STEM students who did not.

Question 3.12.6 Did you play computer games at home?												
	Males 2017			Females 2017			Males 2018			Females 2018		
Degree	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total
Yes	104	22	126	156	15	171	220 76.7 71.90	67 23.3 89.33	287	327 60.67	27 69.23	354
No	89	9	98	159	9	168	86 91.5 28.10	8 8.5 10.67	94	212 39.33	12 30.77	224
Total	193	31	224	315	24	339	306	75	381	539	39	578
Two-sided Pr <= P			0.0823			0.2901			0.0015			0.3127

Numbers represent Frequency, Row %, Column %.

5.2.1.2.6 Choice of major (IT/STEM) and taking the subject Information Technology (IT) at school.

There was a significant relationship between STEM and IT students in both surveys, in their responses to this question. Almost 70% of IT students took the subject IT at school, while only 15% of STEM students took IT at school.

Question 4.6 Did you take the subject Information Technology (IT)?												
	Males 2017			Females 2017			Males 2018			Females 2018		
Degree	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total
Yes	20 62.5 21.5	12 37.5 63.2	32	15 68.2 8	7 31.8 58.3	22	30 50.8 15.23	29 49.2 69.05	59	32 68 9.28	15 32 60.00	47
No	73 91.2 78.5	7 8.9 36.8	80	173 97.2 92	5 2.8 41.6	178	167 92.7 84.77	13 7.2 30.95	180	313 97 90.72	10 3 40.00	323
Total	93	19	112	188	12	200	197	42	239	345	25	370
Two-sided Pr <= P			0.0006			<.0001			<.0001			<.0001

Numbers represent Frequency, Row %, Column %.

5.2.1.2.7 Choice of major (IT/STEM) and having access to a computer at school.

A statistically significant relationship was found in one group of respondents: the male students in the 2018 survey. In this group, about half of the STEM students had access to a computer at school and the other half did not. A significantly larger percentage of the IT students (62%) worked on a computer at school as compared to those who did not (38%).

Question 4.9 Did you have access to a computer at school?												
	Males 2017			Females 2017			Males 2018			Females 2018		
Degree	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total
Yes	125	25	150	247	20	267	243 86.8 53.7	37 13.2 37.8	280	344 47.06	25 40.98	369
No	68	6	74	68	4	72	209 52.6 46.2	61 15.7 62.2	270	387 52.94	36 59.02	423
Total	193	31	224	315	24	339	452	98	550	731	61	792
Two-sided Pr <= P			0.1003			0.7960			0.0052			0.4232

Numbers represent Frequency, Row %, Column %.

5.2.1.2.8 Choice of major (IT/STEM) and having a teacher's encouragement to do well at IT.

Statistically significant relationships were found in all the groups of respondents. The STEM students and the IT students experienced opposite effects: the IT students were encouraged to do well specifically at IT while the STEM students were not.

Question 4.11.2 My teacher encouraged me to do well at IT												
	Males 2017			Females 2017			Males 2018			Females 2018		
Degree	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total
	20	1	21	26	1	27	37	8	45	53	4	57
	95.2	4.8		96.3	3.7		82.2	17.8		93	7	
Never	35.7	6.7		32.5	6.7		34.26	18.18		35.33	15.38	
	13	5	18	21	1	22	29	4	33	40	4	44
	72.2	27.8		95.5	4.5		87.9	12.1		91	9	
Occasionally	23.2	33.3		26.3	6.7		26.85	9.09		26.67	15.38	
	15	3	18	15	5	20	14	10	24	28	5	33
A moderate	83.3	16.7		75	25		58.3	41.7		84.8	15.2	
amount	26.8	20		18.8	33.3		12.96	22.73		18.67	19.23	
	8	6	14	18	8	26	28	22	50	29	13	42
	57.1	42.9		69.2	30.7		56	44		69	31	
A great deal	14.3	40		22.5	53.3		25.93	50.00		19.33	50.00	
Total	56	15	71	80	26	95	108	44	152	150	26	176
Two-sided Pr <= P			0.0405			0.0110			0.0019			0.0087

Numbers represent Frequency, Row %, Column %.

5.2.1.2.9 Choice of major (IT/STEM) and getting information from a guidance counsellor about IT work possibilities.

Statistically significant relationships were found for the male respondents of both surveys. More male IT students reported receiving guidance counselling regarding IT work possibilities than STEM students. Looking at the replies “Occasionally”, “A moderate amount” and “A great deal” all put together, 82% of the male IT students in 2017 and 58% of the male IT students in 2018 reported receiving guidance counselling regarding IT work possibilities. Only 45% and 33% respectively of STEM students reported receiving guidance counselling regarding IT work possibilities.

Question 4.11.4 My guidance counsellor told me about IT work possibilities												
	Males 2017			Females 2017			Males 2018			Females 2018		
Degree	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total
Never	36 54.5	2 16.6	38	56 58.9	3 33.3	59	90 65.22	14 40.00	104	146 62.66	9 52.94	155
Occasionally	16 24.2	5 41.7	21	21 22.1	2 22.2	23	25 18.12	8 22.86	33	47 20.17	3 17.65	50
A moderate amount	8 12.1	4 33.3	12	12 12.6	3 33.3	15	15 10.87	9 25.71	24	26 11.16	1 5.88	27
A great deal	6 9	1 8.3	7	6 6.3	1 11.1	7	8 5.80	4 11.43	12	14 6.01	4 23.53	18
Total	66	12	78	95	9	104	138	35	173	233	17	250
Two-sided Pr <= P			0.0391			0.1742			0.0247			0.0947

Numbers represent Frequency, Column %.

5.2.1.2.10 Choice of major (IT/STEM) and being happy using a computer in work or studies. A statistically significant relationship was found in one group of respondents: the female students in the 2018 survey. 93% of female IT students feel happy using a computer compared to 80% of female STEM students.

Question 5.3.1 I am happy using a computer in my work or studies												
	Males 2017			Females 2017			Males 2018			Females 2018		
Degree	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total
strongly agree, agree	163	31	194	278	19	297	379 83.85	90 92.78	469	590 80.71	57 93.44	647
neither agree nor disagree	9	0	9	10	3	13	62 13.72	7 7.22	69	132 18.06	2 3.28	134

disagree, strongly disagree	21	0	21	27	2	29	11 2.43	0 0.00	11	9 1.23	2 3.28	11
Total	193	31	224	315	24	339	452	97	549	731	61	792
Two-sided Pr <= P		0.0590				0.0831			0.0587			0.0018

Numbers represent Frequency, Column %.

5.2.1.2.11 Choice of major (IT/STEM) and experiencing it as easy to use a computer for work or play.

Statistically significant relationships were found in all the groups of respondents excepting the female respondents of the 2017 survey. More IT students (on average about 88%) feel it is easy for them to use a computer than STEM students (on average about 78%). There are also twice as many STEM students than IT students who feel unsure of this statement. Almost none of the students (in both groups) feel it is hard to use a computer.

Question 5.3.2 It is easy for me to use a computer for work or play												
	Males 2017			Females 2017			Males 2018			Females 2018		
Degree	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total	STEM	IT	Total
Strongly agree, agree	167 86.5	28 80.3	195	279 88.6	20 83.3	299	345 76.50	91 92.86	436	538 73.60	54 88.52	592
Neither agree nor disagree	6 3.1	3 9.6	9	11 3.5	1 4.1	12	95 21.06	7 7.14	102	182 24.90	7 11.48	189
Disagree, strongly disagree	20 10.4	0	20	25 8	3 12.5	28	11 2.44	0 0.00	11	11 1.50	0 0.00	11
Total	193	31	224	315	24	339	451	98	549	731	61	792
Two-sided Pr <= P		0.0299			0.4720			0.0005			0.0333	

Numbers represent Frequency, Column %.

The discussion thus far pertained the categorical independent variables. Now the continuous independent variables will be discussed. These are the matric maths mark and the personality test values.

5.2.1.2.12 Matric mathematics mark that influence the choice of major (IT/STEM).

The matric mathematics marks yielded significant relationships between the female STEM and IT students, between the male STEM and IT students and also between the male and female IT students, all from the 2018 survey. In the 2017 survey, which was smaller, the only significant relationship was between the female students.

Question 4.3 (2017) / 4.4 (2018) - What was your matric mark for Mathematics? (0-100%)		
	Degree (STEM or IT)	
	2017	2018

Factor	Male (STEM vs IT)	Female (STEM vs IT)	Male vs Female (IT students)	Male (STEM vs IT)	Female (STEM vs IT)	Male vs Female (IT students)
What was your matric mark for Mathematics? (0-100%)	z=-1.85, p=0.065	z=-2.02, p=0.043	z=-0.82, p=0.409	z=-2.71, p=0.007	z=-3.21, p=0.001	z=-2.12, p=0.034

In all the significant relationships in this table, the STEM students scored higher matric mathematics marks than did the IT students. In the 2018 male IT student vs female IT student test, the male IT students scored higher matric mathematics marks than did the female IT students.

The numbers of respondents to question 4.3 / 4.4 are listed below.

Question 4.3 / 4.4 - What was your matric mark for Mathematics? - Number of respondents						
	2017			2018		
Factor	Male	Female	Male vs Female (IT students only)	Male	Female	Male vs Female (IT students only)
STEM students	191	311	Males: 31	443	714	Males:96
IT students	31	24	Females: 24	96	61	Females: 61

5.2.1.2.13 Personality traits that influence the choice of major (IT/STEM).

The five personality traits calculated from the Ten Item Personality Test were used to determine if any personality aspects play a role in a student's choice of either STEM or IT-related degree.

The five personality factors ascertained are called "extraversion", "agreeableness", "conscientiousness", "emotional stability" and "openness to experience".

The factor "openness to experience" is sometimes referred to as "intellect" because of its emphasis on intelligence, reflection, ingenuity, originality and curiosity. It is also sometimes referred to as "culture" because it emphasises independence of mind. "Conscientiousness" implies responsibility and dependability while "extraversion" is characterised by

assertiveness, talkativeness and energy. “Agreeableness” means the person is good-natured and cooperative. “Emotional stability” is the opposite of neuroticism, which indicates an easily upsettable person. These traits can be summarised in the following questions:

- Extraversion - Are you sociable or shy? Fun-loving or reserved?
- Agreeableness - Are you trusting or suspicious? Helpful or uncooperative?
- Conscientiousness - Are you organised or disorganised ?
- Emotional stability- Are you worried or calm? Insecure or secure?
- Openness to new experiences - Are you imaginative or down-to-earth? Independent or conforming?

Only two traits yielded a statistically significant relationship: the 2018 male students on the extraversion trait and the 2017 female students on the emotional stability trait.

Question 6 : Personality Traits						
	Degree (STEM or IT)					
	2017			**2018**		
Factor	**Male**	**Female**	**Male vs Female (IT students)**	**Male**	**Female**	**Male vs Female (IT students)**
Extraversion	z=-0.227 p=0.820	z=-0.397 p=0.691	z=0.444 p=0.656	z=-2.505 p=0.012	z=-0.013 p=0.989	z=1.773 p=0.076
Agreeableness	z=0.008 p=0.994	z=0.279 p=0.779	z=1.277 p=0.201	z=-1.473 p=0.141	z=-1.003 p=0.316	z=1.478 p=0.139
Conscientiousness	z=-0.253 p=0.801	z=0.104 p=0.917	z=1.241 p=0.214	z=-0.885 p=0.376	z=-0.579 p=0.563	z=0.893 p=0.372
Emotional stability	z=-0.533 p=0.594	z=-2.017 p=0.044	z=-1.859 p=0.063	z=-1.471 p=0.141	z=-0.564 p=0.573	z=-1.289 p=0.198
Openness to experience	z=-0.617 p=0.537	z=-1.873 p=0.061	z=-0.239 p=0.810	z=0.696 p=0.486	z=0.908 p=0.364	z=-0.054 p=0.957

Among the 2018 male student responses, the male STEM students exhibited a significantly higher mean score on extraversion than the male IT students. The 2017 female STEM students exhibited a significantly higher mean score on the emotional stability trait than the female IT students.

The number of respondents to question 6 are listed below.

Question 6 : Personality Traits – Number of respondents						
	2017			2018		
Factor	**Male**	**Female**	**Male vs Female (IT students only)**	**Male**	**Female**	**Male vs Female (IT students only)**
STEM students	193	315	Males:31	449	725	Males:97
IT students	31	24	Females: 24	97	61	Females:61

5.2.1.3 The hypothesised model

From the individual differences framework (IDT), five hypotheses are proposed (see Figure 29). The IDT specifies a variety of socio-cultural factors that can work together to influence an individual in their choice of IT major. The factors are grouped into three areas: environmental factors that all citizens are subject to, shaping and influencing factors on every individual, and personal factors of every individual that shape their response to the various influences on them. The concentrically arranged spheres of influence allow the researcher to investigate their influence on each other, as well as on the individual's choice of study.

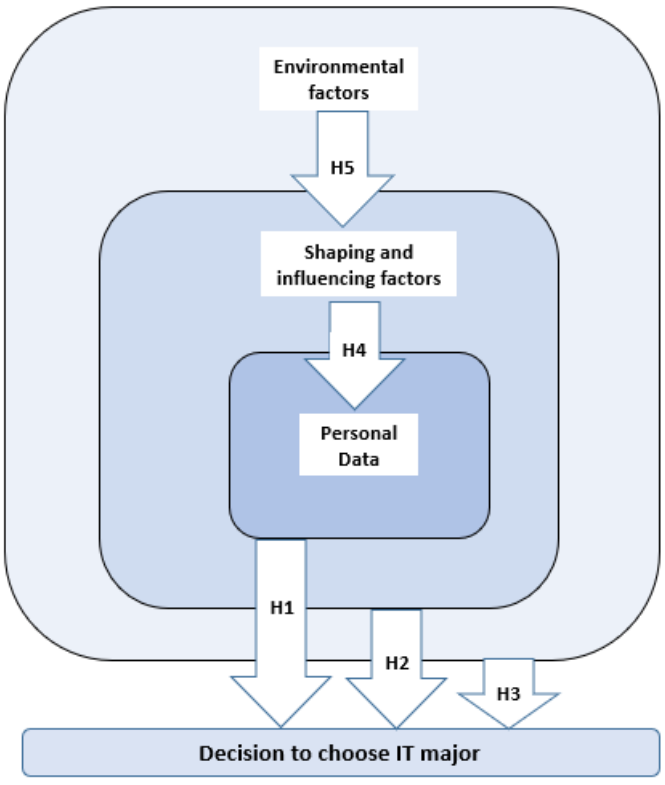


Figure 29: The hypothesised research model of the IT Study Choice Framework

The hypotheses are as follows:

H1(+): Personal data factors (demographic, lifestyle and intended career) have a positive influence on South African first-year female students' decisions to major in IT.

H2(+): Shaping and influencing factors (personal characteristics and personal influences) have a positive influence on South African first-year female students' decisions to major in IT.

H3(+): Environmental factors (cultural attitudes and values, as well as geographic, economic and policy data) have a positive influence on South African first-year female students' decisions to major in IT.

H4(+): Shaping and influencing factors have a positive influence on personal factors in South African first-year female students' decisions to major in IT.

H5(+): Environmental factors have a positive influence on shaping and influencing factors in South African first-year female students' decisions to major in IT.

According to the outcomes of the statistical tests performed above, the hypotheses can be summarised as follows:

Hypothesis	**Decision**
H1(+): Personal data factors (demographic, lifestyle and intended career) have a positive influence on South African first-year female students' decisions to major in IT.	Partially supported
H2(+): Shaping and influencing factors (personal characteristics and personal influences) have a positive influence on South African first-year female students' decisions to major in IT.	Partially supported
H3(+): Environmental factors (cultural attitudes and values, as well as geographic, economic and policy data) have a positive influence on South African first-year female students' decisions to major in IT.	Partially supported
H4(+): Shaping and influencing factors have a positive influence on personal factors in South African first-year female students' decisions to major in IT.	Partially supported
H5(+): Environmental factors have a positive influence on shaping and influencing factors in South African first-year female students' decisions to major in IT.	Partially supported
**** Partially supported, because not all factors identified were significant.***	

The statistically significant variables are now discussed.

5.2.1.4 Discussion

This study investigated the influence of various factors on a first-year student's choice of IT-related major. Since all STEM students qualify to register for IT degrees, the responses of all STEM students were compared and contrasted with the responses of the IT students. The intention was to identify factors that influence these two groups of students in their choice of university degree, and specifically why the STEM students did not choose an IT-related degree.

The respondents were grouped according to their (self-reported) gender. Since the number of respondents who indicated they were neither male not female was so small as to be statistically insignificant, these responses were discarded. Therefore the respondents of this study comprise male and female students who had registered for either IT-related degrees or STEM degrees. To the best of our knowledge it is the first study that investigates and contrasts the factors that influence first-year students to register for either IT-related degrees or STEM degrees.

The first major finding that emerged from this study was that female students from the African and Asian population groups were twice as likely to choose an IT-related degree over a STEM degree, as compared to female students from the White population group. Marsh (2007) found that black South African female students possess a high overall self-confidence which originated in strong female role models they were exposed to in their formative years, and that their self-efficacy has been affirmed by efforts of the South African government to promote women at all levels of society. A caveat added to this finding was that a possible reason for their high computer confidence was the fact that they had had little (if any) contact with computers during their school years. Marsh (2007) called for further investigation into this possibility. Singh *et al.* (2007) cited Margolis and Fisher (2002) who found support for pragmatic and economic reasons for women choosing computer science despite having low computer experience. Seymour *et al.* (2005) similarly found that any perceived lack of computer self-efficacy is overcome by the female students' strong wish to participate in the digital economy. Makoe (2006) found that students were determined to

improve their socio-economic situation and empower not only themselves but also their wider community.

Despite the growing numbers of certain cohorts among female IT students, the different population sizes of the male and female students in this study show that the number of female IT students is still almost half that of male IT students. Since this study allows a view of both STEM and IT students, it is clear that females prefer STEM degrees over IT. There are almost twice as many female STEM students than male STEM students.

The second finding pertains to socio-economics. It seems that STEM students are more likely to have their own room at home and also have their own study table compared to IT students. This poses a threat to aspiring IT students since Sáinz and López-Sáez (2010) found that socioeconomic background accurately predicts whether a student had access to a home computer. Clayton (2007) found that restricted access to computing resources had a strong negative effect on a student's intention to engage in IT studies. However, section 5.2.1.2.6 shows that the IT students had access to computers at school while only half of the STEM students did. This indicates that the use of school computer resources is restricted to the IT students. The good news regarding secondary school access to computers is that Othman and Latih (2006) found no correlation between prior experience and tertiary course grades.

In the case of gaming (section 5.2.1.2.5), it was statistically significant that more (male) IT students played computer games at home than (male) STEM students. It is again encouraging (in terms of female recruitment) that even though the process of gaming allows a player to become familiar with many computing aspects such as configuring and installing hardware and software, Warden, Stanworth and Chang (2016) found that the lack of such knowledge does not preclude students from participating in IT later in life, such as at university.

The third statistically significant finding of the quantitative phase is the link between IT students and the school IT subject. Looking at IT students only, section 5.2.1.2.6 shows that

most IT students took IT at school, indicating that these students had decided on an IT career early on in their secondary school career.

This ties in with the fourth finding which pertains to the role of encouragement and self-confidence. Section 5.2.1.2.8 showed that during their secondary school years, the IT students were more encouraged and guided toward IT careers than the STEM students. Section 5.2.1.2.9 found that male IT students received more counselling regarding IT work possibilities than the STEM male students. These two findings highlight the importance of support from teachers and mentors, especially for female students (Alshahrani et al., 2018). The fact that the female students did not report getting information from guidance counsellors about IT may indicate a possible stereotyping issue. This needs to be addressed since it has been confirmed that there are no statistically significant differences between the grade averages of male and female IT students (Ioannis & Maria, 2019).

The fifth and last finding pertained to computer self-efficacy. Section 5.2.1.2.11 showed that all IT students felt more relaxed and self-confident when using a computer than did the STEM students, while section 5.2.1.2.10 confirmed that female IT students are happier to use a computer than the STEM females. This is confirmed by (Beyer, 2014) who found that students who had higher computer self-efficacy were more likely to take IT at tertiary level. Confidence and feelings of belongingness are crucial to increase representation of females in STEM (Tellhed et al., 2017) and specifically IT.

Section 5.2.1.2.12 describes the statistically significant findings regarding students' matric mathematics marks. It found that STEM students scored higher matric mathematics marks than IT students. This is borne out by the fact that the entry requirements for many degrees such as health sciences, demand higher marks in most subjects than the entry requirements for most IT-related degrees, with mathematics being one of the common denominator matric subjects. In the 2018 male IT student vs female IT student test, the male IT students scored higher matric mathematics marks than did the female IT students. This confirms Speer (2017) who found that boys gain in maths scores relative to girls from ages 15 to 19, which means that boys generally outperform girls in matric mathematics.

The last section describes the statistically significant findings regarding students' personality profiles. The only two statistically significant personality factors found in the two surveys were between IT students and STEM students. The first significant difference found between female STEM and IT students was that the female STEM students scored significantly higher on the emotional stability trait than the female IT students. No studies could be found that performed a similar exercise between IT and non-IT respondents. The closest such study (Cruz et al., 2015) found that programmers (in this case, software engineers) scored lower on emotional stability than the control group of non-programmers, but this study did not distinguish between genders, and it can be assumed that most of the respondents were male. This result contradicts the finding by Trauth (2006) that although females scored higher on neuroticism (the opposite of emotional stability) than males, the IT professionals exhibited a similar need for stability as non-IT professionals. The second significant difference was found between male STEM and IT students. In the 2018 survey, the male STEM students scored significantly higher on extraversion than the male IT students, confirming a study by Trauth (2006) who found that males in the IT profession scored significantly lower in extraversion relative to non-IT male (and female) professionals. That study also confirmed that males in IT scored lower in extraversion than females in IT, a finding not confirmed here.

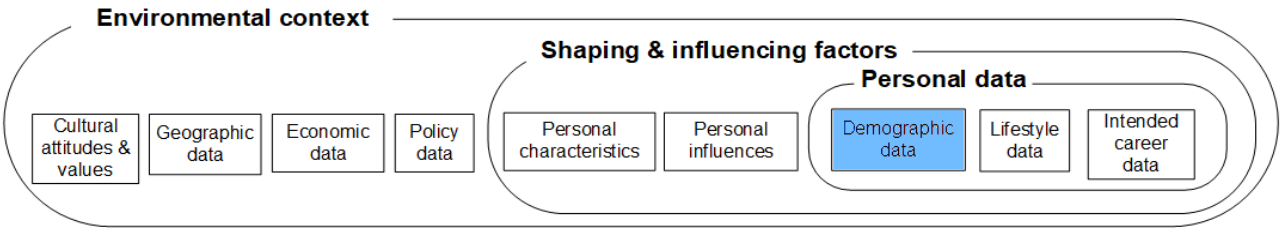
5.2.2 Phase 2 – Focus Groups

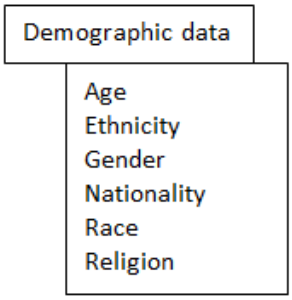
Phase 2 followed Phase 1 by using focus groups to elicit in-depth information from the respondents, who were survey participants willing to participate in follow-up focus groups. Discussions proceeded according to the constructs of the IDT.

The content of the interviews is now discussed according to each of the constructs of the IDT.

5.2.2.1 Personal data

5.2.2.1.1 Demographic data





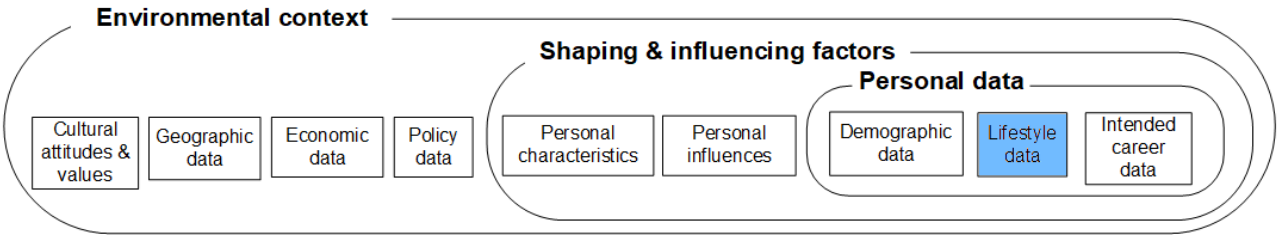
Age – between 18 and 22
Ethnicity –3 Europeans, and 18 Black Africans of which 2 are Tswana and one Northern Sotho. The other respondents' ethnicities were not specified.
Gender – 5 males and 16 females
Nationality – 19 South Africans and 2 Zimbabweans
Race – 18 Black Africans and 3 Whites
Religion – Not requested in questionnaire and not volunteered during interviews

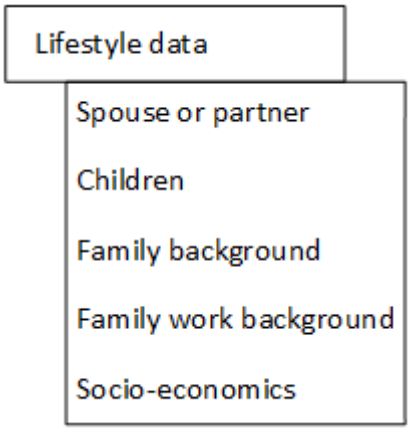
Age : Most of the respondents were between 18 and 20 years of age; having just written matric or taken one gap year. Two of them had changed their direction of study after experiencing the subject matter in class and realising they were more interested in another field of study. The respondents in the pilot study were three years older since they were busy with respectively in their third and fourth years of study.

Nationality : All were South African nationals, except for two Zimbabweans who attended

school in that country. There were 5 males and 16 females, among them 3 Whites and 18 Black Africans.

5.2.2.1.2 Lifestyle data





Spouse/partner – no respondents had spouses. Two respondents were in a relationship and the others were single
Children – No respondents had children of their own
Family background – 13 students report living with both parents, five live with their mother as head of household, two with another family member, and one lives with a guardian
Family work background –16 respondents' parents have tertiary education, and all bar two parents work full-time
Socio-economics – All respondents had their own rooms, computers and internet access, except for two. (Both came from single-parent households - headed by their mothers)

Lifestyle data provides a picture of the home life of the respondent. In keeping with the underlying theory, the respondents were asked for their relationship status and whether they have any children of their own. Recent statistics show that some students in this country have children of their own (USAF, 2018, p11) "Many of our students might have responsibilities that go beyond their own individual success (e.g. parenting, caring for siblings)". However, none of the respondents in this study are married or have any children.

When asked about their childhood home, eleven of the respondents report having grown up in a in a town or city, seven in a rural area and three in a township. Most respondents (17) hail from the Gauteng region and north-westwards (North West, Mpumalanga or Limpopo). One is from the Free State and one is from the Eastern Cape. Both pilot study respondents are from Zimbabwe.

The majority of the respondents (16) report that their parents have tertiary education. This means that they can be classified as continuing-generation college students (CGS). Only 5 of the 21 respondents are first-generation students (FGS) who report that their parents have passed either matric (1), secondary school (2), primary school (1) or possess no formal education (1).

Socio-economic aspects of respondents' study funding reveal that the study fees of a small number of students (3) were paid by their parents. These are from households with both parents present and of whom at least one was professionally employed. Four respondents report having received a National Student Financial Aid Scheme (NSFAS) bursary, and one (NAS-3) reported that she gets an allowance from her two brothers, since their father had left them and her mother is unemployed. The respondents who study with an NSFAS bursary are all also first-generation students.

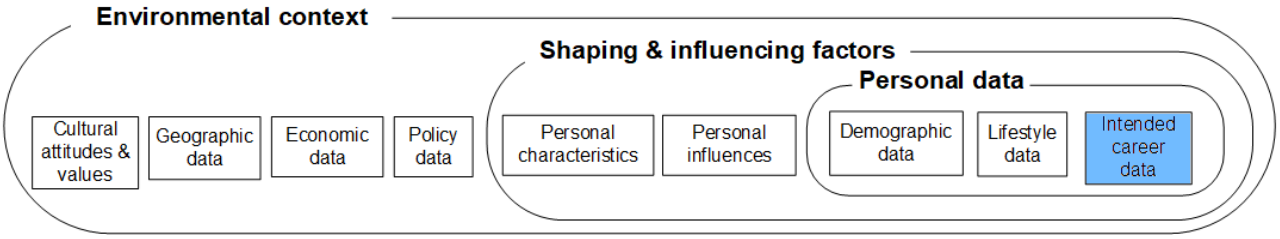
Most respondents (14) reported living in a household with both parents present, while 5 reported living in a household with a single mother as head of household. Regarding parents' occupation, 19 respondents' parents work full-time. Of the children from these households, most had their own room and computer with internet (18).

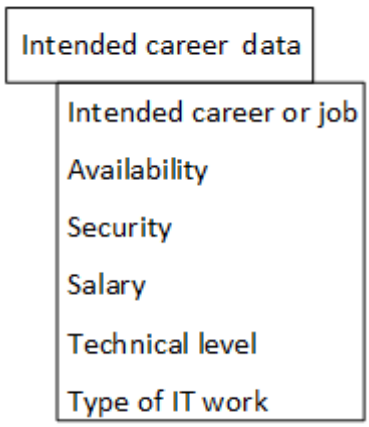
Respondents in two different focus group sessions commented that their families were actively supportive of their studies. This meant that material wealth (or the lack of it) has a big influence on a scholar's study choice. People who have enough money to live comfortably can afford to let their children study anything they prefer, while scholars from poorer households are expected to study something that brings in money, which they have to send home for the first few years. (This phenomenon is discussed next, under the "Intended career" factor). One respondent ascribed the phenomenon to race, while two others ascribed it to household income only : "Most people want to get a job that brings in lots of money because I suffered a lot when I was young and for White people it's not all about money but also about the children's likes and dislikes" (NAS-3). Respondent EBIT-P said, "Someone from a less well-off household will have to choose a job which gives a good income, while someone from a well-off household would have the options to choose to follow

their dreams. For example, they can do drama if they feel like that will make them happy". Respondent HUM-P agreed and added "There are different cultural groups in Zimbabwe, but there is no real difference between them in this case because the parents want their children to do well financially in their chosen jobs".

The phenomenon of family support in Black African households should be discussed under Environmental context, but is discussed next, under the "Intended career" factor, since this study found a clear relationship between culture and the way students decide on careers.

5.2.2.1.3 Intended career data





Intended career – many students are pressured into following high status, high-paying careers. People are unaware of possible IT careers.
Availability – few students are pro-active in finding out about possible jobs for themselves. In this study, only 7 out of 21 respondents researched available studies/careers.
Security – only one student took job security into consideration.
Salary – good remuneration is avidly sought and associated with high status careers. Family puts pressure on student.
Technical Level – IT students assumed a direct correlation between technical difficulty of their degree and possible job opportunities.
Type of IT work – not considered.

Intended career data allows a focus on the intended career of the respondent, including aspects such as job availability and salary. This information can be gleaned from family, career guidance professionals, career fairs, or from online research by the individual.
The **Intended Career** aspect allowed a unique finding of this study to emerge : that Black African students are encouraged from a young age to pursue a respected and well-remunerated profession – one of the "Big Five" careers, as the respondents put it. These

occupations enjoy high status and offer superior income. They are well-known occupations that have been around for a long time, and are familiar to the older generations. The “Big Five” occupations were listed by the respondents as doctors, lawyers, accountants, engineers and pilots. The respondents’ families put considerable pressure on them to follow these high-status jobs : “I was told that you’re not going to be anything if you’re not doing the Big Five – gives you status . You are then known and respected.” (Respondent HUM-1). NAS-1 said, “My parents took it seriously – they wanted me to be a doctor. I said that I wanted to be a doctor when I was small and they loved the idea and kept talking about me being a medical doctor. It’s a status job.” and “My friends said they want to be doctors and make a lot of money. When you’re up there then people say “yôôô!” … It’s a status job). Respondent HUM-P talked about the necessity of having a career with high earning potential “… your parents want you to do a job like medicine, engineering, accountant … they want you to have something tangible”.

However despite the pressure from family, and willingness to live up to expectations, many students do not qualify to study the requisite degrees. Three respondents described their experiences in identifying and applying for a degree. IT-7 said “I wanted to do Medicine...but I only had a level 4 for mathematics and no-one allowed me for Medicine.” She subsequently chose IT studies. Similarly, respondent IT-8 said “I wanted to study Industrial Engineering ... I took maths and physics (at school) so that it opens many doors for me. But I didn’t get good marks in them.” Respondent IT-1 said “I wanted to enrol for Law, but the access was blocked, and then I looked at other faculties’ courses that I qualified for, using the uni webpage”.

The disconnect between academic performance and intended career among the respondents reflect the findings of USAf (Universities of South Africa), which partly ascribes the gulf between expectations and reality to the fact that these students are the first in their family to attend university. The USAF report adds that study and career guidance is likely lacking and concludes that “Most of our students are simply driven to study anything that might help them and their families into a better life” (USAf 2017). As respondent NAS-3 put it: “Traditionally, poor black people encourage their children to aspire to high status jobs/careers in order to have lots of money“ and also “Most people want to get a job that

brings in lots of money because I suffered a lot when I was young…" This fact is echoed by respondent IT-6 who said "My dad also says we should do something to make money...". Students striving towards well-remunerated careers do not only do it for themselves, but for their families as well. The concept of communal reciprocity was very clearly illustrated by the Black African respondents in this study: that of sending home a part of your salary as soon as you start earning. In the very first interview group, the pilot study group, the participants clearly stated that "kids have to study something that brings in money, which they have to send home for the first few years". Respondent NAS-3 described it as "Those who do land jobs in high-paying careers then pay for things at home (parents, siblings) before taking any money for themselves". This is a well-known aspect of the African collectivist culture (Triandis, 2001) and is the same in the ethnic cultures of South Africa (Eaton and Louw, 2000). Respondents repeatedly refer to their families' role in their studies. EMS-4 talked about working hard not to disappoint those sacrificing their income to pay for her studies: "The family's investment is on me" and EMS-5 describes the reciprocal relationship as "the family feels we would be advantaged to have at least one member in commerce who would help guide and support the family".

Respondent NAS-3 said that her brother works and studies at the same time, but still manages to provide for his siblings: "…my brother got a bursary because he got good marks. He also knew dad could not pay for him. We are four children. When my father left us, he (my brother) paid for my school fees …. He was studying but also working. So he had to put his life on hold to get the three of us (siblings) an education.My mom doesn't work".

The phenomenon is called "black tax" (Magubane, 2016; Jadezweni, 2018) and ".. is a colloquial term for sharing your salary with family and making sure that they are well taken care of before considering taking care of yourself. It feeds an expectation that a person may be liable to carry a burden if they've studied and found a job. That expectation extends beyond immediate family to extended family as well." (Mtolo, 2018, p.1). Black tax is a moral responsibility that people have towards their community, which influences their status and social reputation. Not all black African people are affected by this however – "…not all black people are unselfish or believe in helping others who are in financial trouble" (NAS-3).

This definition of “black tax” differs markedly from that in the United States, where “black tax” is seen as a notion that African Americans experience pressure to work harder than White Americans in order to be on par with them, or to be taken seriously in the workplace (Whiting, 2009; Philips et al., 2015).

A finding following directly from the fact that students pursue well-known, high-status careers, is the fact that they and their families are unaware of IT career possibilities. The parents and family members who financially support the students, exert an influence on the study choice of that student, since they would eventually like to have a return on their investment. The older generation is well aware of the traditional, conventional professions but know little of the IT profession. It is these older generations that influence and encourage the young people toward the perceived status careers and therefore ignore available IT careers.

This situation is exacerbated by the fact that scholars receive little or no career guidance at school (see the discussion of the aspect “Curriculum and teaching” under the construct “Personal characteristics”).

The next two factors in the Workplace construct, job **availability** and **security** showed that very few students find out about possible careers for themselves. They rely on career fairs coming to their schools. According to NAS-1 “Most school kids …. wanted to finish school and get a job... Very few who wanted to go study and not worked directly. Few who want to get more information. Luckily we had career days at school which was great for those who wanted to find out for themselves – but most kids just wanted to get free stuff from the tables.” The same respondent added that “…Expo people were very important to give us info”. Respondent NAS-2 echoed “Few people from my school get to university….. They don’t find out for themselves. The teachers advise generally but do not have the information what there is or how to get there. Secondly people don’t get a lot of support from family. Mostly they tell you to be a nurse or a teacher but if that is not what you want to do, you have no alternative. We all checked for ourselves. My sisters too…. you need to be self-

motivated. If I didn't do my own background check then I would not be here. I did all my online research and applications myself."

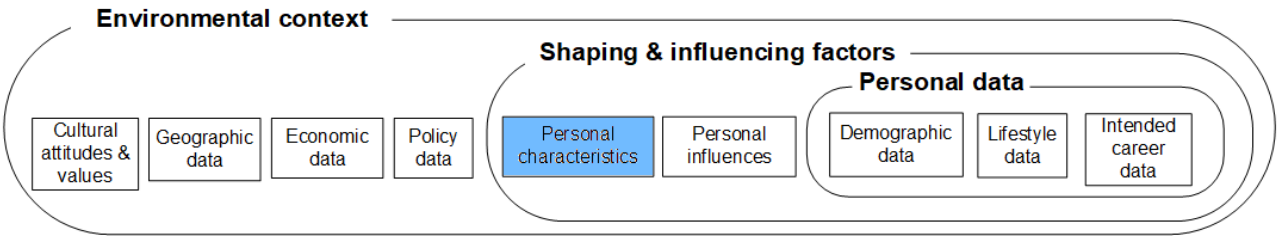
The **Salary** aspect highlighted the fact mentioned at the start of this discussion, namely that students select the careers with the best possible earning potential. Respondent EMS-4 commented on the way scholars decide on a career by searching the salary first : "Kids always start at the salaries of the jobs they think of doing".

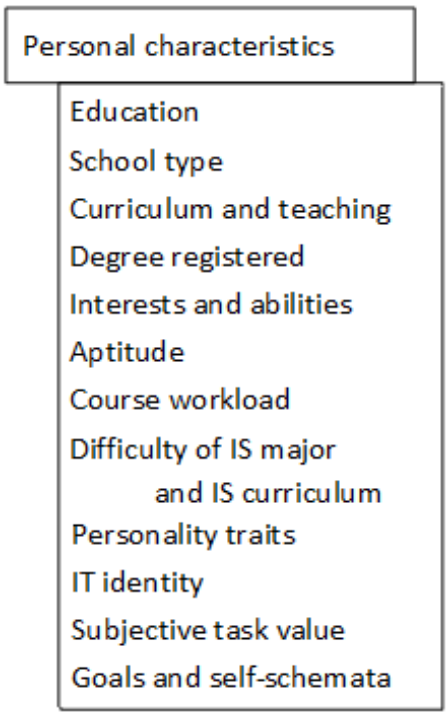
No respondents commented on the **technical level** or, in the case of IT students, the **type of IT work** in this construct. A possible explanation could be that no thought had been given to the type of work the respondent could be involved in after obtaining a qualification. Yet despite there being little consideration of the expected technical level of their future careers, two IT students reasoned that the fact that they are studying a technically demanding subject, indicates that their skills would be scarce and therefore in high demand : "…. not everyone has that experience…. The chance that you are doing something worthwhile means you can get a proper job" (respondent IT-3) while respondent IT-4 said "I suppose Computer Science is fairly difficult because there is a 90% fail rate in the first test. I reasoned that if I completed such a difficult degree I would probably not struggle to find a job."

5.2.2.2 Shaping and Influencing factors

Shaping and Influencing factors consist of two constructs : Personal characteristics and Personal influences. The Personal characteristics construct contain factors such as educational background of the respondent, interests and abilities , aptitude, course workload and personality traits. It includes goals and self-schemata which allow a glimpse of the respondent's life perspectives. The Personal influences construct refers to experiences, and other people who have influenced the respondent and shaped them to become who they are. It includes factors such as significant life and educational experiences, early computing experiences, as well as role models in the life of the student.

5.2.2.2.1 Personal characteristics





Education – all respondents have matric with university admission, all attended good schools.
School type – all respondents attended co-ed schools except one who attended a girls only private school.
Curriculum and teaching - all respondents reported teaching at their schools were good. almost all reported they received no career guidance counselling at school.
Degree registered – IT degrees have lower entry requirements than the high-status degrees.
Interests and abilities – a wide variety, indicating talented individuals.
Aptitude – students confidently choose subjects they are good at.
Course workload – difficult but doable.
Difficulty of curriculum – IT has a reputation for being a difficult subject.
Personality traits – two IT students confessed to being highly asocial and introverted.
IT identity - all reported positive IT identity except for one Humanities student and two EMS students.
Subjective task value – all respondents feel they will make a difference in the workplace.
Goals and self-schemata – all live by the motto "Work hard to get a good job".

The first three factors of the Personal characteristics construct are Education, School type and Curriculum and teaching. All respondents report having attended good schools, respondent IT-6 saying that her school was good even though it was in a small town, and EBIT-1 saying they had good teachers and were given many opportunities while at boarding school. Most respondents attended co-ed schools. One (EMS-5) held a bursary to attend a private girl's school where the facilities were excellent and the classes small. She also had a mentor assigned to her, with whom she still keeps contact.

Only two respondents out of 21 confirmed that they received career counselling at school. The others reported that they received no career guidance counselling while at school. One respondent reported that they were given career surveys to complete and were assisted by career professionals (EMS-5). This respondent attended a private girl's school. Another respondent, IT-6, said their school had one guidance counsellor, but that the "guidance counsellor only helped those who went to him".

A combination of factors regarding school IT subject curriculum and teaching, became salient during the interviews : that the schools the respondents attended generally had inadequate IT hardware, inadequate IT teaching and neglected their IT subjects in favour of mainstream subjects. The reason for the latter pertains to Admission Point Score (APS) scores.

The APS system assigns values to achievement levels for every matric subject. A matriculant's APS score determines admission to university studies, and all efforts are consequently focused towards maximising it. The various tertiary education institutions in South Africa have different entrance requirements, and the matric subjects Information Technology and Computer Applications Technology contribute differently toward the APS score. These factors lead to some schools encouraging scholars to focus on the high-contributing subjects to the detriment of the IT subjects to maximise the student's chances of being accepted for university studies. Respondent EBIT-1 said "I was not allowed to take a difficult subject like IT because they want us to maximise our marks" and respondent EMS-2 said "we had CAT but it didn't count towards my APS score – so I thought I can't take it because it won't help me. But I think CAT/IT does count now".
Two respondents identified computing infrastructure problems and sub-optimal IT teaching as preventing scholars from taking IT subjects : "Schools should have good IT teachers. Our school's IT teacher was good but many times he didn't show up for class." (IT-6). Respondent IT-1 said "my school offered IT & CAT. I Took IT. But the school computers were poorly maintained. People at school don't know much about IT. They made me hate IT. It was more fun and engaging to do IT at home." This indicates that bad school IT experiences can lead to long-term negative attitudes toward Information Technology.

The APS scoring issue holds an unexpected advantage for prospective IT students - the IT degrees have lower entry requirements than the traditional high-status degrees such as Medicine and Law. This means that students more easily qualify for IT studies. Respondent IT-8 said “another advantage is that you don’t need such high marks for Informatics. If it wasn’t for Informatics then I would have taken a gap year and upgraded my maths and physics mark.” So too respondent IT-1 who “..wanted to enrol for Law, but the access was blocked, and then I looked at other faculties’ courses that I qualified for, using the uni webpage. I applied for BCom Informatics.“

The students in this study were registered for a variety of degrees : one each of BEng Mining Engineering, Development studies (Hons), BA Humanities, BA Social Work, three doing BCom Accounting Sciences, two studying for BCom Financial Sciences, one each studying Bsc Agric Animal Science, BSc Biochemistry, BSc Medical Sciences and BSc Quantity Surveying. The IT students were registered as follows: one studying BIS Multimedia, one BSc Information and Knowledge Systems, one BIT Information Technology, two studying BCom Informatics Information Systems and three who were busy with BCom Informatics.

Most respondents listed a large number and variety of interests for the factor Interests and abilities. They could indicate any of the following: sports, arts & crafts, computer activities, culinary pursuits, cultural arts, nature, music, literature, socializing and travel. one student (EMS-4) selected only “literature” and NAS-3 selected nature, music and travel. The others selected most of the possible interests, indicating that they are likely all talented and well-rounded individuals.

The respondents showed that they are well aware of their respective Aptitudes and they successfully chose subjects they like and excel at. Two BCom students, EMS-1 and EMS-3, told of their early interest in numbers and their love of the school accounting subject, and said that it was therefore easy to decide on their field of study. “I enjoyed accounting in high school and my ability to do it” (EMS-1). The engineering student EBIT-P was also very sure of her study choice, and said that she wasn’t interested in IT because she knew what she wanted to study. HUM-1 who studies BA Social work, said “I’m not a numbers person but I’m an interpersonal person”, indicating a good fit for her chosen career.

There were two different types of responses to the Course workload and Difficulty of curriculum factors. The Information Technology students and the Engineering student reported their studies as being difficult, and described it as a heavy load. EBIT-P who was in her third year of BEng Mining Engineering described it as “Very heavy. Discouraging.” IT-3 feels the same: “..the COS122 practicals .. You just don’t know where to start...and that does a lot to your self-esteem – breaks it down”. IT-4 agrees and says, “but I feel too guilty to give up because my father pays for my studies”. IT-6 calls the workload “High but worthwhile” and explained that her sister had just completed an IT qualification and she was immediately employed. Respondent IT-1 said, “COS (Computer Science modules) is difficult. I struggled to understand the scope but I knew it was relevant”. In the same conversation, IT-2 said, “I was not scared of the university course load. I wanted to do something in IT no matter the course load”. Respondent IT-3 who studies BIS Multimedia had the following to say about the high dropout rate in the COS subjects : “ I probably won’t blame them for doing this (dropping the subject) ….it does a lot to your self-esteem……coding and running it and it not working … can really demoralise you ….because it can make you feel “maybe I’m in the wrong place” … and when you don’t have a support system you’re likely to give up - and start thinking who am I to think I can do it? So the people you surround yourself with … people who know what’s going on - you know - who can help you - … - it gives you hope”.

The Non-IT students did not refer to their own studies when talking about the course workload and difficulty of curriculum factors, but referred to IT studies. As respondent EMS-1 explained, “I know someone who does computing, so it’s doable, but everyone told me it is difficult. And a friend had computer science last year and it was horrible! And she even changed. She’s now doing BCom General”. Speaking about the school IT subject, respondent NAS-1 said, “IT looked difficult”, HUM-P said, “I think IT is difficult“ and EBIT-1 said, “Many people left IT because it is hard”.

From the reaction of the non-IT students, it is clear that IT has a reputation for being a difficult subject, both at school and at university level. Respondent IT-6 had a solution to this attitude : “… they have this mentality that they think programming is hard. That’s the reason why

most people don't do programming. Then if people hear I am doing programming they say "how are you coping?" and I tell them it's not like that, it's like maths. You just have to practise it".

The presence of the Personality traits factor in the theoretical framework, encouraged two respondents to discuss their own personalities. IT-5 explained his study choice in terms of his personality : "Computer Science was my first choice. It is about my personal traits. I am not good at dealing with people. I am not a social person. I told myself I would never do anything related with dealing with people. People are trouble. I would rather deal with a cell phone or a machine that would not respond negatively….I would rather create something that would help people every day". When respondent IT-4 said, "I've always been a loner. Fine in a small crowd but nothing more. But if it becomes too many people I get way too nervous", IT-5 agreed "I don't even attend parties, I can't cope" and IT-4 continues, "Neither do I …also because I don't drink alcohol or smoke so I have nothing in common with most people that go to parties and things….."

The data for the IT identity factor once again highlights a difference between IT majors and non-IT majors. The non-IT majors disparaged the subject content, as HUM-P said, "I found computers really hard to study...I don't know (laughs) … It was difficult for me. I didn't like numbers and so I took something (at university) with people in it – the humanities". Another humanities student, HUM-1, said, "It is confusing, we did not have the time to go through computers in-depth. We do not know what IT entails". In contrast, the IT majors experienced joy and a sense of accomplishment in their IT encounters. According to IT-4, "I chose IT over accounting because accounting sounded so boring… saying I was a computer scientist sounds much cooler than saying I'm an accountant". IT-8 describes it as, "I've always loved computers. I've always sat at my laptop, figuring out PowerPoint. I'm a bit artistic… So.. I'd rather spend 10 hours on a computer than write with a pen on paper".

IT-1 reported that "I grew up playing IT with friends and get sucked into it and so I guess it just feels normal for boys to play with computers or do IT" and "IT was easy for me to understand. The more you work with PCs, the more you get comfortable around it – you get to know what to do, where to look, how to look". IT-2 agreed with this: "I felt comfortable

working with computers. I Agree with (IT-1) in the more you work on computers, the more you get comfortable".

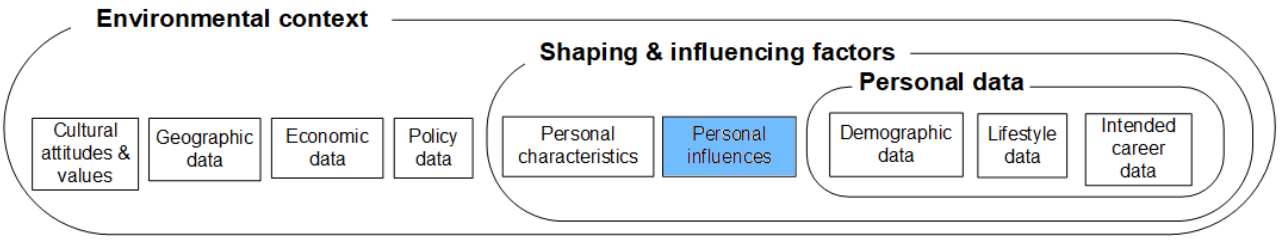
One positive aspect came to the fore during the different discussions of the respondents' IT identity, which is that IT identity can change. EMS-4 said, "I knew nothing of IT and did not have access to computers. I never thought it was for me. It was scary. But I now realise I could do IT. Why didn't anybody tell us about IT?" EMS-3, studying BCom, said "Now I find programming interesting and would like to learn how to program. But at school I did not have IT because I thought I would struggle". EMS-1 said, "I was afraid on hearing that we use computers so much in actuarial sciences. All is done by computers. I was told programming is difficult and that's why I did not do it – but **now** I want to learn programming at my own pace and not be pressured in it". EMS-2 agreed saying "I agree … about doing IT at my own pace. I like doing things myself so much that I get frustrated when I battle with doing it on the computer. And when my guy friends come and do it so quick – it frustrates me (groans, laughs). IT is interesting, I would like to do it – on the side**".** These experiences show that a non-existent or negative attitude toward IT can be changed, whether through education or positive experiences with IT, provided the individual is in control of the process.

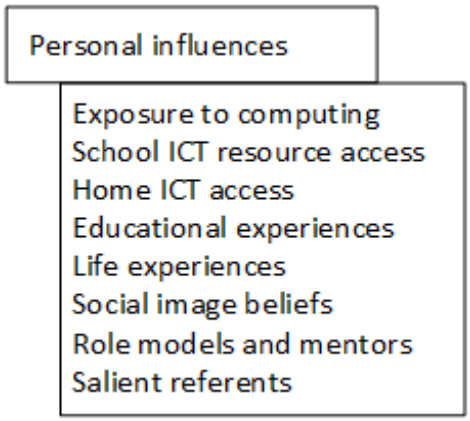
The last two factors of the Personal characteristics construct, Subjective task value and Goals and self-schemata work together to determine an individual's choice of career, the preceding choice of studies, as well as persistence therein. The concept subjective task value refers to how important an individual perceives a task to be. In the case of career choice, respondent EMS-2 felt strongly about making a difference in a country plagued with corruption : "As a CA (Chartered Accountant) you are driven by ethics – in CA ethics is your law. I like that CA gives me power to influence, for example, the running of the country". HUM-P who was doing Honours in Development studies, felt strongly about helping people : "I always had an interest in wanting to help people, looking at different cultures and backgrounds and how certain people live, and try to understand how it came to be, and find ways to help people". She planned to use her knowledge to "understand the African side of development and then the donor side of development" and then combining them to affect a difference in many people's lives. Self-schemata refer to a set of long-term memories that summarise an individual's beliefs about the self, over various behavioural domains. All

students interviewed, live by the motto “Work hard to get a good job” (EMS-2) and “Work hard to reach your goals” (IT-6). NAS-2 said, “I am ready to learn, I like to do my own research and find (a career) so that I can follow my passion” whereas EMS-4 talked about being a perfectionist - "Burning sensation to success" but at the same time a fear of failure : "I must not fall into unemployment statistics".

The aspect Goals and self-schemata allows us to revisit a factor mentioned earlier : the students’ willingness to live up to expectations of their families. This willingness to conform to societal pressure was mentioned in the Workplace construct. A related issue cropped up during the interviews – the fact that many students eventually realise they would rather spend their time working on qualifications (and subsequently careers) they prefer, rather than those envisaged for them by others. As respondent IT-8 explains “Our parents want us to do certain things and we see we want to do something else and we don’t want to disappoint them because they work so hard to pay for us”. Then respondents described how their own preferences eventually overrode family expectations : “If you say you do medicine then everyone says *wonderful* ! But making money is not the only thing – you have to enjoy what you are doing” (HUM-1). “I wanted to apply for medicine but I mistakenly applied for BSc Medical Sciences. I had applied at other uni’s for medicine... But this was a blessing in disguise because I am enjoying it now” (NAS-3). Respondent EBIT-1 said that “My family wanted me to become a medical doctor but I registered for quantity surveyor because I would have had to do a bridging year. They wanted me to do the bridging year. But I was not interested”. The struggle between loyalty and self-actualisation seems to end happily for most, as the same respondent, EBIT-1, mentioned “The only reason my grandfather allowed me to do QS (quantity surveying) was when he saw my sister’s friend driving a BMW and she was a QS”. IT-6 mentioned her sister’s experiences : “My dad also says we should do something to make money but we should also enjoy it. My sister actually changed to IT behind their back – at varsity – she didn’t like accounting – so she switched subjects by herself. She did very well in IT. My parents did not know exactly what IT entails but now that my sister did it, they know. So they supported me to go into IT”.

5.2.2.2.2 Personal Influences





Exposure to computing – differs greatly among students. School ICT resource access – lacking, even in resource-rich schools.
Home ICT access – one student had home access to comprehensive ICT technology, five students had PCs for playing games, and the others had no home ICT access.
Educational experiences – all had good teachers.
Life experiences – job shadowing helps identify a career.
Social image beliefs – university degrees have status.
Role models, mentors
Salient referents
} Allow an individual to see the 'larger career picture'

The Personal influences construct consists of data on people, experiences and infrastructure that directly influence the individual at an early stage of life.

Exposure to computing differed for the respondents in the study. Computer access and use was either at home, playing games (as reported by EMS-1, NAS-1, NAS-3, IT-2, IT-4 and IT-6) or using computers at school. The private schools were most successful in this aspect, having better infrastructure: EMS-5 had an academic scholarship at an all-girl's private school. She said "..we got more exposure to high tech. It was a first-class school. A small matric class, there were only 40".

School ICT resource access remains inadequate, with only a third of respondents having access to computers at school. Respondent IT-6 said that their school had computers but they were reserved for the IT students, and that she therefore never had access since she took neither CAT nor IT. Respondent IT-2 confirmed that their school had computers for everyone to use, but that each scholar had a limited time to work on them. He took the subject IT and the time allowed on the school computer was never enough. He said that he

would not have been able to finish his work if he did not have a friend whose computer he could use. IT-7 wanted to do IT at school but thieves had stolen the computers and so she couldn't. NAS-2 said, "We only had 24 computers which was not enough for everyone at school. If you didn't have a computer at home you were at a disadvantage coming to university. Some students have never seen or used computers before and that made it very difficult for them to do certain tests or reports where students need to use a computer".

Only a few students have Home ICT access. Respondent EMS-1 and NAS-3 played games at home, either on their own laptop or a family member's. IT-2 played on friends' computers outside of school hours. Only one respondent spoke of access to a range of IT functions: IT-4 said, "I did not have access to tech at school, but I did at home. There I had easy access to all forms of technology so it was easier to get into tech if it was there".

The discussion between respondents IT-1 and IT-2 then moved beyond IT access to IT interest. Respondent IT-2 told of his keen interest in IT, but his inability to afford ICT technology : "You can have the (tech) but not be interested in using it to its full potential. The level of interest makes the difference" and then IT-1 agreed: "access to computers does play a role in eventual interest, but the level of interest plays a bigger role". From this it may be deduced that after an individual's initial exposure to computing, the actual *interest* in IT seemed to be the deciding factor.

When considering any Educational or Life experiences that influenced their study choice, the respondents all said they had good teachers. Three respondents mentioned that they had no guidance counsellors at school, and one mentioned that they did have a counsellor but the onus rested on the scholars to go and consult him. Two respondents mentioned that they received some career counselling based on psychometric tests, such as EMS-1 who, "Had access to a career test that showed my interests, strengths and weaknesses".

Life experiences that had an influence on career choice included respondent HUM-2 whose family "moved around a lot which triggered depression in me. There was a lack of social workers and psychologists in schools and rural areas. I was motivated to go into this field of

work because I am so driven to help people who need someone to talk to". NAS-1 mentioned that job shadowing helped her decide on a career.

Respondents have shown that they are very aware of Social image beliefs of their intended careers. EBIT-P states that, "engineering is a status job" while IT-3 describes it as "It feels so good when you're around family members and you're telling them you're studying something in IT – at a university!". On a practical level, EMS-4 says, "A degree gives you a voice in the workplace".

Role models and mentors and Salient referents are people who are important in a young person's life, offering long-term support or advice. Half the respondents in this study commented that they enjoyed support from family and friends. NAS-2 was grateful to her family who "..gave so much support to keep me motivated during my studies". HUM-1 found her siblings to be role models : "Almost all of my family went to university. I was inspired by my siblings". Respondent IT-6 has two family members in IT: her sister and an uncle: "My Uncle is an IT manager at Standard Bank and he said I must go into IT. He said many of the interns studied BCom Informatics and that it is a very good degree and I can do a whole lot of jobs with it"

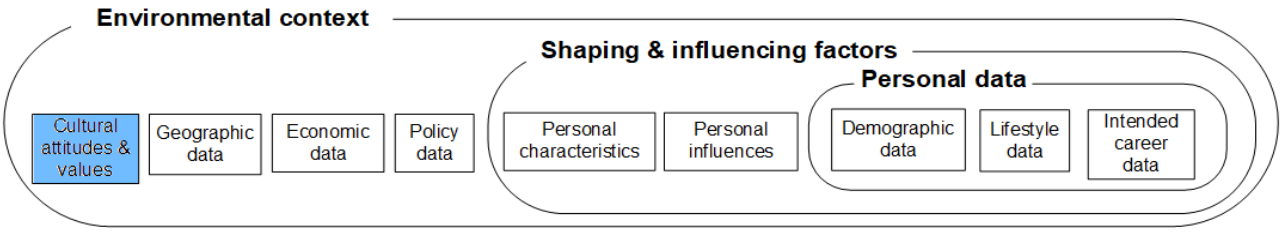
Two respondents had mentors assigned to them during their school years. One of them, EMS-5, still keeps contact with her mentor. These two respondents talked about activities they do outside of studies to improve their employability, and credit their mentors for helping them think like that. EMS-4 said her mentor advised her to "network and then build on that". She did some work at the Rag office and said "Doing Rag gave me so much experience I can put it on my CV. When I went to see the Tuks counsellor she said that this work experience / volunteering will make it easier to get work".

One respondent, NAS-1, said that she made her study choice completely by herself and that no-one helped her. She knew that she did not want an office job and that she loves animals. The media introduced her to career possibilities and a teacher played a minor role : "My life sciences teacher had a career book full of possible careers and she allowed me to page through it to see careers involving animals".

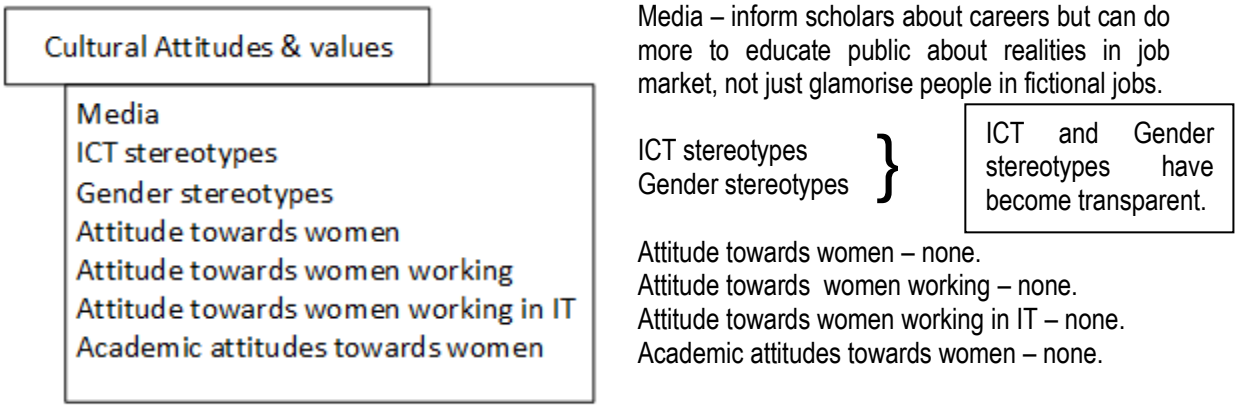
5.2.2.3 Environmental aspects

The Environmental aspects construct provides a context for the various cultural, geographic, economic and policy factors within which the respondents are situated and which informs their responses.

5.2.2.3.1 Cultural attitudes and values



The construct "Cultural attitudes & values" refers to the respondents' own and regional society's cultural attitudes about work and women in work. It includes stereotypes held by the various role players in a student's life, as well as the beliefs of the individual students themselves. It includes the influence of popular media.



The **Media** played a huge role in informing and influencing respondents' opinions of careers. NAS-1 said that "I looked at NatGeo and Animal Planet and that's how I chose my career. It exposed me to possible work opportunities. I saw Khan academy – I was so interested in

IT. But I would still choose animals because I do not want to work in an office". Respondent IT-3 saw girl programmers who seemed cool and she wanted to join them : "Many crime shows I watch on TV have very cool smart female characters who seem to excel in coding which I found interesting and I wanted to be like them". IT-5 said that, "The media advertised the need for IT graduates, showing students coding. It influenced me."

Conversely, three respondents demanded more information : IT-6 said "The media doesn't have much about IT" while IT-8 said "I read up about 'systems analyst' but did not know what it meant". IT-4 criticised it saying, "The media is a form of propaganda. It made IT look like it is a field of study for people who want to make and play games".
These responses indicate that media are a powerful yet under-utilised tool for career information dissemination. Media also greatly influence stereotyping.

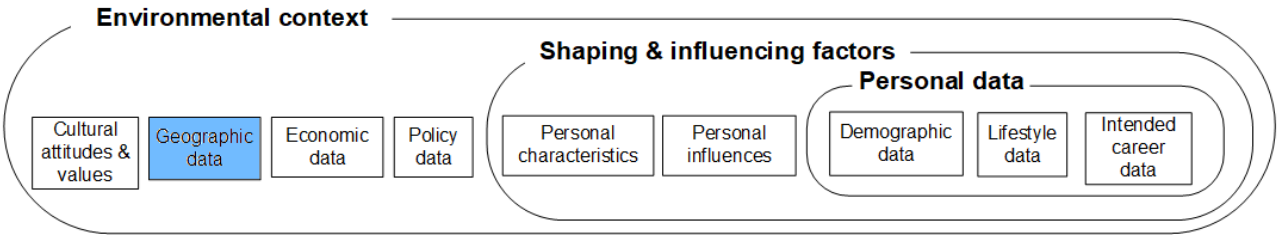
ICT stereotypes and Gender stereotypes, while still present, have lost much of their power. Respondent IT-7 laughs disparagingly while talking about the reason boys are more confident in IT: "Boys are confident enough to do IT – while you are doing the dishes, your brother is sitting in front of the computer". She acknowledges the situation without approving of it. Respondent NAS-3 dismisses stereotyping and stresses agency by saying, "Our culture does not influence us any more – like girls have to be submissive – it is not there any more. You now have a drive of what you want to do, it is not the culture saying so". Respondent IT-2 also rejects the idea: "Stereotypes – no. I think anyone can (do IT). It depends on your interest in IT – how deep you want to get into it – anyone can have an interest in anything". IT-1 is of the opinion that, "The geek image does not carry much weight especially when the earning potential is there. Geek stereotype is not true - look at Bill Gates".

The lack of response in this study to the last 4 factors which regard attitudes towards women, indicates an absence of any issues regarding women in work. Not only are the stereotypes universally recognised for what they are, but the prejudices that lead to them are dealt a fatal blow by simple pragmatism: the need to rise out of poverty. Results from the first phase of this study, the questionnaire, confirm this finding: of the 19 respondents who completed the questionnaire, all 19 agreed that they respect both their male and female lecturers, and

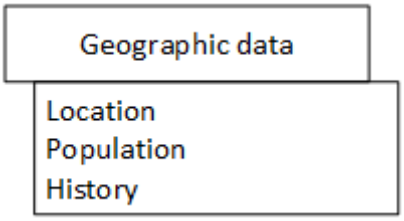
that they think women are just as effective in IT as men. Out of these 19 responses, 4 replied with 'Agree' and 15 with 'Strongly Agree'.

This finding mirrors a study on gender and IT in Ireland, which shows that the higher the economic importance of an industry, the more open-minded the attitudes are regarding women working in that field (Trauth, 1995).

5.2.2.3.2 Geographic data



The construct Geographic data provides information about the respondent's geographic region of origin. This includes history and population characteristics.

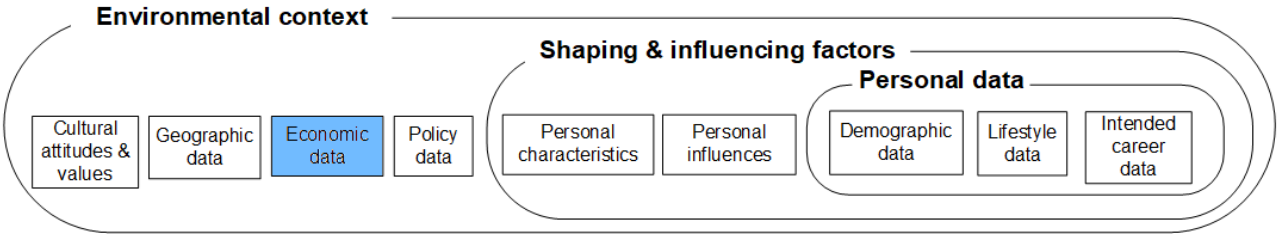


The Location aspect allowed a picture to emerge that most respondents lived in cities or rural areas. Respondent IT-8 said "I'm from a rural area but we are not limited to information. We get it from the internet". Only three respondents said they came from small towns and described it as follows: IT-6 said, "Small Town people have no knowledge of IT jobs" and NAS-2 described it as follows: "I come from a small village in Limpopo, we are Pedi, and there was little information of the world outside – it felt like your mind was in a box. My parents tried to make us see outside our village, and I would travel because my father lived in Joburg. There are few people where I come from who inform themselves of what is going on 'out there'. Coming from a small rural area can be a disadvantage due to lack of

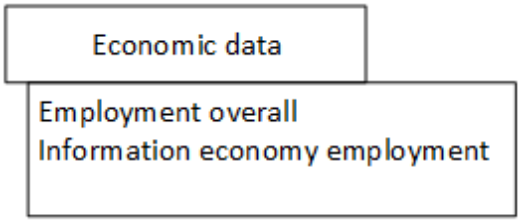
resources and motivation but for me it was an inspiration because I've learned that my background does not define me, it inspired me to change my situation".

The Population and History aspects drew no comments from the respondents, yet one issue became salient upon reflection of all the responses. This is the fact that the older generation, (the parents and grandparents of the students), know only the traditional professions they experienced. It is the older generations that influence and encourage the young people to prepare for a successful career, yet they are mostly unaware of IT profession career opportunities. Only when they see a successful incumbent, do they incorporate IT into their schema of desirable careers. Respondent IT-6 explained how it happens: "My Sister did computer science at Pearson Institute. … She now works at Standard Bank in Rosebank. She is studying Customer Relationship Management and when she gets the certificate she can go and work in America and get 100 000 every month. That's why at home they said I must go and study IT. They see it's very easy to get jobs, and it's in demand. So my Dad was – 'Pick any career as long as it's in IT'."

5.2.2.3.3 Economic data



Economic data provides information on the underlying socio-cultural context of a respondent. For the population of this study it includes availability of employment and economic aspects such as bursaries and how the student's expenses are afforded.



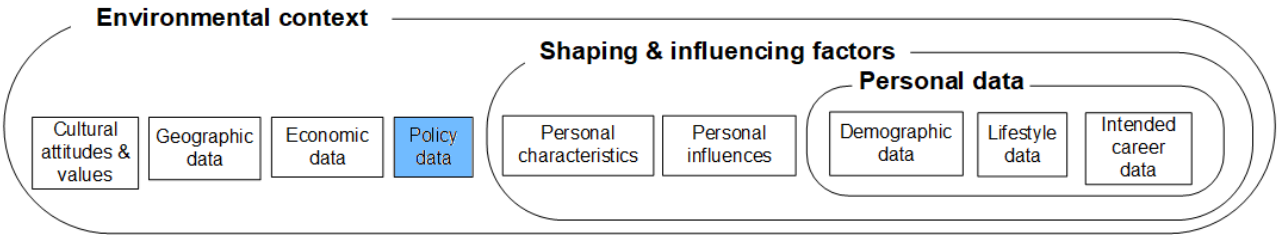
Employment – real unemployment of 36%
Information economy Employment – available
Economic aspect for students - NSFAS bursaries given to working-class students

Unemployment in South Africa is among the highest in the world. Official unemployment is 26%, but when the numbers of people who have stopped looking for work is included, it rises to 36% (Masutha, 2018). In contrast, the demand for skilled ICT practitioners continues, both locally and globally.

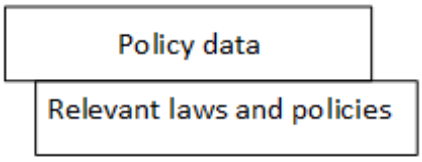
The South African ICT sector contributes approximately 6% to the country's R4 trillion GDP, yet it continues to suffer from insufficient skills to meet demand (Schofield, 2018). Respondents are well aware of this situation – "There's a big demand for IT people" (IT-2); "There is employment in SA in the IT field" (IT-5 and IT-5).

To enable deserving scholars from working-class families to attain well-remunerated jobs, the South African Government provides support through the National Student Financial Aid Scheme (NSFAS). This allows qualifying students to aspire to their dreams of a better life. As respondent IT-5 reports: "I have a NSFAS bursary. My mom does not work and my father does not support us. I have to work to get marks". Respondent NAS-3 says, "I got a NSFAS bursary. My allowance I get from my brothers. Two of my brothers are engineers and they help out where they can. Because my father left us". Another IT student, IT-5, describes it as follows: "I chose IT because of the improvement it brings to not only my life but everyone's life. Having to get a bursary also influenced me because no-one could pay for me (before) and after I got the bursary my family approved though they had no knowledge about IT or the job availability."

5.2.2.3.4 Policy data



Policy data provides further socio-cultural context within which students, being respondents of this study, need to function and thrive.



South African labour law protects citizens against unfair discrimination, according to the Constitution. Furthermore, the Constitution acknowledges that previously disadvantaged groups of citizens deserve to be advanced by affirmative action measures. The disadvantaged groups are African, Indian and Coloured people, women, and people with disabilities. Coupled with the historic under-representation of women in traditionally male jobs such as Engineering and Information Technology, this provides attractive career prospects for suitably qualified women. Respondents are aware of such opportunities : EBIT-P mentions “Preferential hiring for women engineers”.

5.2.2.4 Discussion

Every interview was concluded by asking the respondents to list the reasons they chose to register for their current studies. The non-IT students mostly replied that they have no interest in IT : “IT is not for everyone. I’m not really interested (and don't understand) the concept of IT” (HUM-2). “I do not need IT skills in my intended job” (EMS-5). Some accept that they will be using it in their work in future : EMS-1 said, “I have really never been exposed to the IT fields. I have never been interested in IT. I decided not to study actuarial sciences because of fear of doing programming. I have never imagined my day to day life with computers”. NAS-2 said “I did not want to specialise in IT because my passion is in Biochemistry. However I have realised that IT is important in every field because we need it to carry out most of our work”.

Many also did not know what IT was, or misjudged its importance. EMS-2 reflected, “Because back then I didn't see the importance of knowing how to use IT. But since IT has become the main medium of functioning in all areas of life, so now it's actually an area of interest. I'd like to do IT in the near future”. “Because I thought I would struggle in this field, because I did not have any IT background in school” (EMS-3).

NAS-1 : “I did not know anything about IT until I came to university. I accidentally stumbled across Khan Academy which has a programming division. That's where I discovered IT. If I had known about it, I might have taken IT“. NAS-3 : “I did not know what IT entails, how it works. I was never exposed to information about it” and similarly HUM-1 : “It is confusing, we did not have the time to go through computers in-depth . We do not know what IT entails” EMS-4 said “I didn't like computers, because I didn't have access to them. They're scary. I prefer writing. But I'm developing an interest in it. But I now realise I could do IT”

The IT students’ replies showed that they mostly ended up registering for IT as a happy coincidence, many of them also not knowing precisely what they were registering for. Only two of the eight respondents registered for IT as first choice: “Why did I register for IT? Playing games. I wanted to understand IT. Informatics was my first option. My second option was accounting. I also applied at Wits. But I’m glad I got into Informatics at Tuks” (IT-2). Respondent IT-3 also said “I wanted to have a secure future with promising employment opportunities”.

Respondent IT-4 knew he wanted to do IT but was not sure which degree to register for : “It was a passion to see how computers worked and after much thought I eventually decided to follow my interests. I went into Informatics without knowing what the difference (to Computer Science) really was. Because I originally applied for Computer Science but it was full when I applied so I got forced to choose a different module (Informatics)”. IT-5 said “I did not know what Computer Science was” and so to IT-6 who confirms that “ People know nothing about IT”.

The other respondents happened upon IT as a second choice : IT-7 said the reason she registered for IT was “Not qualifying to study medicine. Also the desire to move with the growing technology. I was also interested in doing business and IT together”. IT-8 explained that, “If it wasn’t for Informatics then I would have taken a gap year and upgraded my maths and physics mark. That (qualifying for Informatics) really motivated me because I was really discouraged”. Lastly, IT-1 explained, ”Why did I choose IT? Initially I did not want to do IT at all. I wanted to be a musician. But carrying around a lot of heavy stuff showed me I didn’t want to do it all my life. I wanted to be academic - but I only qualified for Informatics. I went

along with it because I knew the IT field was my best bet, regardless of how vague and limited it seemed. I wanted to enrol for Law, but the access was blocked, and then I looked at other faculties' courses that I qualified for, using the university webpage. I did not know what Informatics was, but the more I researched it, the more interesting it got. Even if you google Informatics, it's a hugely broad term, it doesn't mean anything. But I saw it was something in the tech field, and I thought "Hey, that's a way in!"

The relative obscurity of the IT career is an issue of significant value to the process of deciding on an IT major. During one of the group discussions, a facilitator, who was an Informatics Honours student, mentioned what she perceived as a difference between a traditional career and an IT career. She observed that students of traditional degrees work at their studies because they have a passion for it and that there is a well-defined job at the end, as opposed to IT people who work at IT because of the pleasure of doing IT itself and not focusing on the end goal. This impression was repeated independently in a subsequent focus group. Respondent IT-1 observed that, "There are no defined 'paths' in IT qualifications and careers. IT is very cross-disciplinary. It is a change from the tradition. Instead of getting the required level of certification and then doing the job, in IT you study and then do anything remotely related to IT." Respondent IT-2 agreed and contrasts it with a CA who has his study and work path mapped out - "in IT, where's your endpoint? It's vague – you know what electives to take but you don't know where you are going to fit in, in the whole (area of IT careers)".

This situation is confirmed by the latest South African ICT Skills Survey (2018) where the author laments the absence of a standardised description of skill sets for the industry.

At the conclusion of each focus group session, the discussion automatically turned to suggestions how scholars can be encouraged to do IT. The respondents enthusiastically volunteered a variety of suggestions. The suggestions regarded access to computing hardware, knowledge of computing study and job opportunities, and marketing to address the general ignorance of computing opportunities.

Three respondents described barriers they experienced at school. NAS-1 said, “Not having access (to a computer) is a big reason why so few students do IT because they don’t know what it is. My friends told me I would not be able to take IT because I did not have a computer at home to use”. NAS-2 echoes this by explaining, “If you want more kids in IT, you need to spoon-feed them to get into IT. Many want to do IT because they take IT to get out of the country. Kids also need their own computer because you don’t know how long it’s going to take you to figure out a problem – an hour or a day? That’s why you need your own computer 24/7”. IT-8 talked about the mathematics requirement and translated it into perceived IT subject difficulty: “About IT in schools : they want a high mark in maths so I thought IT was difficult because it required a high maths mark. I thought if I can’t make it now, why would I make it in tertiary?.” IT-6 also mentioned a general perception of IT subject difficulty: “People don't do programming because they think it’s hard. If people hear I am doing programming they say ‘how are you coping?’ and I tell them it’s not like that, it’s like maths. You just have to practise it”.

A lack of knowledge about IT career opportunities also hamper uptake: as NAS-3 tells: “Even though I used a computer from a young age, I did not know what IT entails, how it works and I was not exposed to information about IT. If I knew, I might have considered IT. I just went with what I saw. This information thingy – not many people from my high school study it. Everyone knows about doctors, lawyers and so on but not IT”. In another focus group, respondent IT-1 said the same thing: “I did not know what Informatics was. I did not know about careers in IT. There are no good descriptions of actual careers – it’s interesting to read about artificial intelligence, etc, but there is no information on careers in it – and it is difficult to find out. The career options list under the informatics brochures of the various universities are a bit vague. So I did BCom with a bit of IT. only after studying for a year I started to realise what it actually involved.”

EMS-4 asked, “Why didn’t anybody tell us about IT? All we know are the Big Five – Doctor, Lawyer, Accountant, Pilot, Electrical engineer. I think computer science should be compulsory at school. And counting toward university entrance. Because there might be more kids who get more interested, and when someone is not interested in making it a career

then they at least know how to use computers in their jobs. Africa is still behind in that. We need to get everyone on board".

Most respondents suggested efforts directed at scholars. NAS-3 said "Before matric (when people just concentrate on getting good marks) they should start telling students about IT and how it works, and how much the money is. It would help for people to assess their strengths and weaknesses. You fail when you are not aligned with your job. Visit high school students from a young age and tell them what IT is. And tell them how they will get money from computers". Respondent IT-2 said, "To catch someone's attention you have to show them how to use the technology to do something they care about like using the phone to switch on something – to show them what you can do with tech – something cool. So that they ask, "How did you do it?" It's a way to hook people. According to IT-5, "They (universities) should tell students in high schools of the courses they offer. They should reach out to as many schools as they can. In 2010 when I was in grade 10 we came here and I did not know what computer science was. I remember I wanted to do aeronautical engineering. They took us to SciEnza and told us the history of the university. They told us about engineering, and the health sciences but nothing about computer sciences."

Two respondents suggested IT starts in primary school. IT-7 feels it would inspire confidence in the subject : "I think start in primary schools. Because in high school you think of what career you want to follow, so that by that time you know about IT and interested in doing it". IT-6 confirmed that, "When in grades 10,11 very few people know what they want to do. I feel at school they should talk about IT like they talk about other careers, like accounting. Schools should have good IT teachers. Our school's IT teacher was good but many times he didn't show up for class. That's why I think schools don't take IT seriously. They don't realise that technology is the future. I think they should start with IT in primary school. With gaming".

Respondent IT-8 had the last word : "Send information to schools. Send a representative of specifically the IT degrees, explaining exactly what IT is…because when you think IT you think, yo!, literally breaking down a computer and…it's not that!"

5.2.2.5 Findings

The interviews highlighted clear barriers to students' decisions to enter IT studies, which are that:

- Information Technology jobs lack status in the minds of many students and their families when compared with the traditional (or "mainstream") image of a doctor or a lawyer;
- people (both parents and scholars) do not know or understand what a career in IT entails, nor that it offers good remuneration;
- students do not know what tertiary qualifications (in IT) are available; and
- students are of the impression that they are automatically excluded from tertiary IT studies if they do not have the matric subject Information Technology.

5.2.2.6 Conclusion

The interview phase indicated that one of the most important causes for the low uptake of IT studies at school and university was ignorance of the IT field, and that learners and their families simply did not know what Information Technology was, or how they could join the party. Those who were slightly better informed were intimidated by the perceived complexity or difficulty of the subject and self-selected themselves out of it before investigating the fit.

Prospective students who did not qualify for their first choice of major found that they qualified, amongst others, for various IT majors. After investigating the matter they then registered and, in so doing, entered the IT field.

The last data gathering phase followed logically from information gathered in the interview phase. A one-page questionnaire was created to further investigate the aspects identified in phase 2.

5.2.3 Phase 3 – Open-ended Questionnaire for Informatics students

The questionnaire for the last phase of the study was distributed to a group of students who were registered for a first-year Informatics module. These students were a subset of the population that completed the survey in phase 1.

There were five questions in total (See section 4.5.2.2). Preceding the first question was an area for the respondents to indicate their gender. The first question asked the respondents to indicate how they decided upon their chosen field of study. The second question was an open-ended enquiry regarding the reasons the student decided to sign up for their major. The third and fourth questions asked whether the respondent would have taken the subject IT at school (had it been available to them) and whether they knew about IT career opportunities (while at school or at least before they exercised their study choice). The fifth question was an open-ended prompt to ask for suggestions on how scholars could be attracted to IT studies.

The content of these responses was analysed as suggested by Erlingsson and Brysiewicz (2017). The written replies to each question were transcribed and, as such, formed the manifest content. Using a spreadsheet, four tabs were created following the responses, respectively called Content, Codes, Category, and Themes. Four columns were created on each tab for the last four questions that were asked on the one-page questionnaire.

By way of a number of passes through the responses, the content was systematically condensed into codes. A code can be seen as a label that describes the condensed meaning unit. A category organises codes according to aspects of the text that belong together. Categories show what is visible in the data by answering questions such as “what”, “who”, “when” and “where”. Themes are latent content found in two or more categories. They answer the questions “why?”, “how?”, “in what way?”, or “by what means?”

Each question and its responses will now be discussed by first providing basic descriptive statistics and then showing how the codes and categories were identified. Lastly, the themes for all four questions are presented in a diagram.

The data was quantified by adding the number of responses to each code and calculating it as a percentage of the total number of respondents. This means that the percentages displayed do not add to 100 since many respondents replied with more than one answer to each question.

5.2.3.1 Demographics – Degree registered and gender

The demographics of the students who completed the questionnaires are listed in Table 23. Of a total of 253 respondents, 107 were male and 143 were female. Most of them (77%) hailed from the commerce faculty, while the others (23%) majored in IT (either Informatics, Information Science or GeoInformatics).

A quick glance at the student demographics for the various IT qualifications presented at UP (Appendix I) helps put the respondents' replies in perspective. The illustrated subscription demographics reveal that more male students register for IT degrees than female students, except for the degree BIS: Publishing. In retrospect, the study in phase 3 would have been strengthened by the presence of respondents registered for BIS Publishing.

5.2.3.2 Responses to question 2: How did you choose to study this degree?

The top three influences on a student's choice of university major were:

- own interest or enjoyment of the subject (33,94%);
- suggestions from family or friends (13,65%); and
- job security (12,05%).

The other factors included an affinity for the subject field, good remuneration, and the perceived status of the career. From the responses it can be seen that students rely more on social media (4%) and doing their own career research (2,41%), than relying on career counsellors (1,2%) or teachers (1%). It is also clear that they gleaned more information about their intended careers from university open days and industry presentations (1,61%) than from career counsellors. Salary played a surprisingly small role (4,02%) in the respondents' choice of studies and career. The quantified responses can be seen in Table 27.

Table 27: Responses to question 2: How did you choose to study this degree?

Response	%*
Own interest / Enjoyment / Own choice	33,94
Family / Friends	13,65
Job availability / job security / demand for skills	12,05
Career I want / Skills to enable me to follow the career I want	7,43
Love Maths/ Accounting/ business	6,43
Subject(s) that I excelled in at school	5,42
Money/Salary	4,02
Media / social media	4,02
Own research done	2,41
Unsure of study / career I want to follow	2,01
This module is a prerequisite module for my degree	1,61
Open day at university or accounting firm presentation	1,61
Respected profession (status) / image of career	1,41
Guidance / career guidance	1,20
Teacher	1,00
Degree - internationally recognised	0,60

*Percentages do not add to 100 since many respondents replied with more than one opinion on ways to attract people to the IT field.

It is interesting to see that there are a number of first-year students who are still unsure as to the qualification they would like to complete, even though they are already registered for and studying toward a degree. They responded by writing that they are still unsure of the studies or career they wish to follow (2,01%). Some respondents misunderstood the question “How did you choose to study this degree” and interpreted it as “How did you choose to study this module?”. They replied by saying that they had no choice since the module was a prerequisite to their degree (1,61%). Only 0,6% of the students replied that they took the degree since it is internationally recognised.

A number of subtle differences could be identified by plotting the commerce students’ responses apart from the IT students’ responses, to the question, “How did you choose to study this degree?” (See
Figure 30).

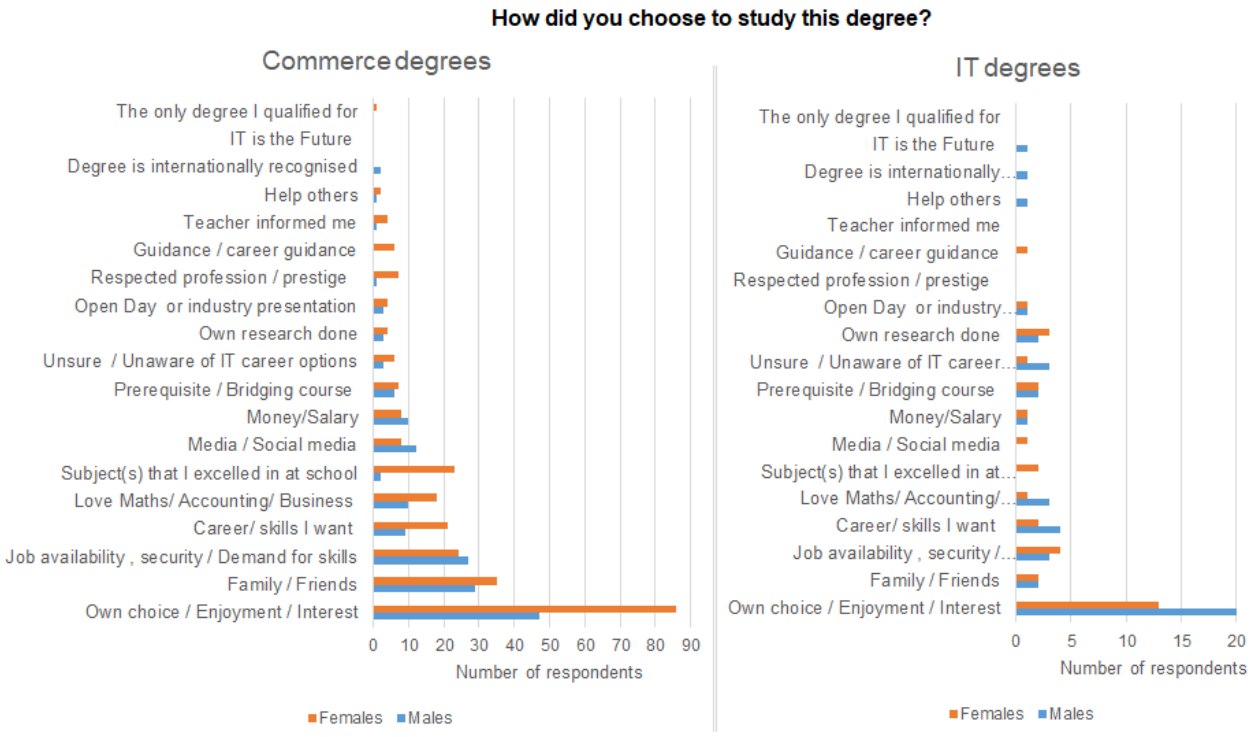


Figure 30: Two degree groups' responses to "How did you choose to study this degree?"

The largest contributor to the choice of degree was the individual student's own choice or interest in the qualification. Within the commerce students' responses it can be seen that females are more likely to offer this reason than males. Within the group of IT students, the situation is reversed: more male IT students than female IT students indicated that taking the degree was their own choice, or due to their enjoyment of the subject matter.

Family and friends played a much larger role in the study choice of the commerce students than the IT students, while teachers played no role at all in the IT students' choice of major. Another salient difference between the two groups can be seen in their attitudes towards the perceived status of their intended careers: the commerce students viewed their prospective careers as being prestigious, while none of the IT students considered IT careers as being prestigious.

5.2.3.3 Responses to question 3: If your school had offered the subject Information Technology (IT), would you have taken it?

More than a third of the respondents simply replied that IT does not interest them, but a few supplied reasons, such as that they are unable to code or that the IT subject is difficult. Another third replied that they would have taken it by justifying that it is a skill for the future. 16% of the respondents replied that they would have taken IT at school because they are interested in the subject while only 4% profess that they love it and find the subject fascinating. A few respondents replied that their academic workload would have been lighter had they taken the school subject IT (see Table 28: Responses to question 3: If your school had offered the subject Information Technology (IT), would you have taken it?).

Table 28: Responses to question 3: If your school had offered the subject Information Technology (IT), would you have taken it?

Response	%*
I do not like it / I am not interested, it is boring	38,18
Yes, I am interested in the subject	16,73
Yes, because it's a skill for a technological world	16,73
Yes, because it's the future	15,64
The IT subject is difficult	4,73
I love it, I find tech fascinating	4,36
My university workload would have been reduced if I had taken IT at school	2,55
I can't code	1,09

*Percentages do not add to 100 since many respondents replied with more than one opinion on ways to attract people to the IT field.

These responses can be collapsed into four categories:

I don't like it, not interested, it's boring, it's difficult. I can't code	44,00
Yes, it's a skill for a technological world, it's the future	32,36
I'm interested in it and find tech fascinating	21,09
My university workload would have been reduced if I had taken IT at school	2,55

The theme of the responses to this question can therefore be seen to be three different approaches to the school subject IT: one of complete indifference, one of interest and actual

passion, and one pragmatic approach where the respondent understands and accepts that the subject has to be mastered to ensure career success.

5.2.3.4 Responses to question 4: When you were at school, did you know about available studies or careers in Information Technology?

The responses to this question fell into one of three categories: either yes, no, or only partly. The percentages can be seen in Table 29: Responses to question 4: When you were at school, did you know about available studies or careers in Information Technology?.

Table 29: Responses to question 4: When you were at school, did you know about available studies or careers in Information Technology?

Response	%*
Yes	33,43
Partly	15,85
No	21,90
Unaware of IT jobs	28,82

*Percentages do not add to 100 since many respondents replied with more than one opinion on ways to attract people to the IT field.

A third of the students were aware of IT careers while they attended school. Almost 22% did not know at all and 15% were only partly informed of the possibilities that IT careers offer. 28% of respondents replied that they knew about IT qualifications available but that they were unaware of the various IT careers in industry.

Knowing only partly about jobs in IT means that people rely on stereotypes, that are, at best, misleading, and ,therefore, the last three categories' responses can be consolidated:

Yes	33,43%
No	66.57%

This means that only a third of the respondents knew about the variety of IT career possibilities available to them, and two-thirds did not have enough information to make an informed career choice.

Splitting the responses to this question into two groups, the BCom students' responses and IT students, the results remain very similar (see Figure 31).

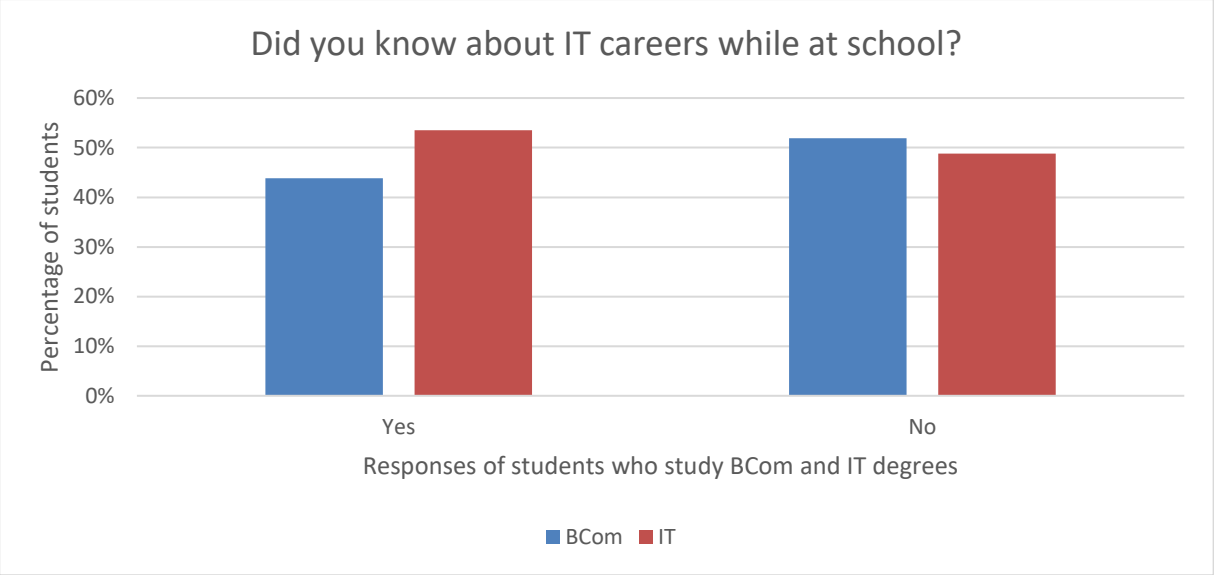


Figure 31: Two degree groups' responses to "Did you know about available studies or careers in Information Technology?"

Even though less BCom students than IT students were aware of possibilities in the IT field, more than 40% of the BCom students were aware of IT career possibilities and yet they chose against it.

5.2.3.5 Responses to question 5: How do you think can we attract more people to jobs in IT?

Most respondents (22.96%) are of the opinion that the most successful way to attract people to the IT field would be to inform them of the need for IT specialists and the corresponding

availability of jobs in IT (see Table 30: Responses to question 5: How can we attract more people to jobs in IT?). The second largest response to this question (15.56%) called for education and more practical examples of IT jobs to be made available to combat misconceptions of the field. The third most popular suggestion (12.84%) states that scholars need to be persuaded of the importance of IT in the business world since knowledge of IT is necessary for any job nowadays. Following that, the respondents suggested advertising the pressing need for IT specialists in the media, specifically using the platform social media (10.89%). The next group of respondents (10.12%) were of the opinion that more schools should introduce IT, and, at the same time, to begin teaching it in lower grades.

Table 30: Responses to question 5: How can we attract more people to jobs in IT?

Response	#	%*
Job possibilities / The increasing need for specialists in IT/ awareness of jobs in IT / for the need for IT workers / career guidance	59	22.96
Give practical examples / share more information of the job / increase understanding of the job / show benefits of IT / combat misconceptions / education / introduce scholars to IT	40	15.56
IT is the future / future workplace / one should be technology literate / computers and IT are in your daily work / the influence of IT / explain the importance of IT in the business world	33	12.84
Advertise better because people don't know about need / Media / Social media / Articles	28	10.89
Teach them young / more schools should introduce IT	26	10.12
Interesting / variety of things to do / good IT programs at school	20	7.78
Career fairs at schools / workshops / Professionals visit schools, especially rural schools	20	7.78
Money – IT jobs offer good salaries	19	7.39
IT subject is boring/tedious / IT subject is difficult / Remove theory workload	9	3.50
Fun / show what makes jobs in IT enjoyable	9	3.50
Remove social stigma / stereotype / no work-life balance	7	2.72
Individual's own interest / passionate about IT / strong liking	5	1.95
Show how to get into IT career / show it's not so difficult	4	1.56
Keeping up with developments in technology	2	0.78
Keep programming languages relevant	2	0.78
Hardware unaffordability	1	0.39
Job Shadowing	1	0.39
Mentorship	1	0.39
Hand out sweets at career faire stands	1	0.39
Offer bursaries	1	0.39
Present more IT courses	1	0.39
Flexible workhours of the IT career	1	0.39

*Percentages do not add to 100 since many respondents replied with more than one opinion on ways to attract people to the IT field.

Three groups of responses represented 7% each of all responses to the question. The first group called for school IT programs to be made more interesting with a variety of activities designed to stimulate interest (7.78%): “They can be attracted if they realise how interesting it is rather than describing it as being complicated”, “Teaching computers from a young age. Making technology 'cool' and 'fun' and 'interesting' as well as user-friendly” and “By incorporating it in each subject”. The same number of respondents highlighted the importance of career fairs and expos held at schools. They call for professionals to visit schools and especially rural schools. The last group indicated that the above-average salary structure of the IT field is a way to attract people to the field.

Two groups, each representing 3.5% of all responses to the question, mentioned similar but opposing aspects: one group mentioned the perceived difficulty and tediousness of the IT subject while the other group called for presenters to inform prospective entrants of the fun side of IT jobs. “I think before we could talk about jobs in IT, it all starts from lower school and people get more interested to study further. But if we just start learning at university then we won't want anything to do with IT. It will seem difficult” and “show the fun side of the job to people. Make an effort to show what makes jobs in IT enjoyable. Share more information on it.”

Splitting the responses into two main groups of respondents, being the commerce students and the IT students, allows a finer focus on the data (see Figure 32).

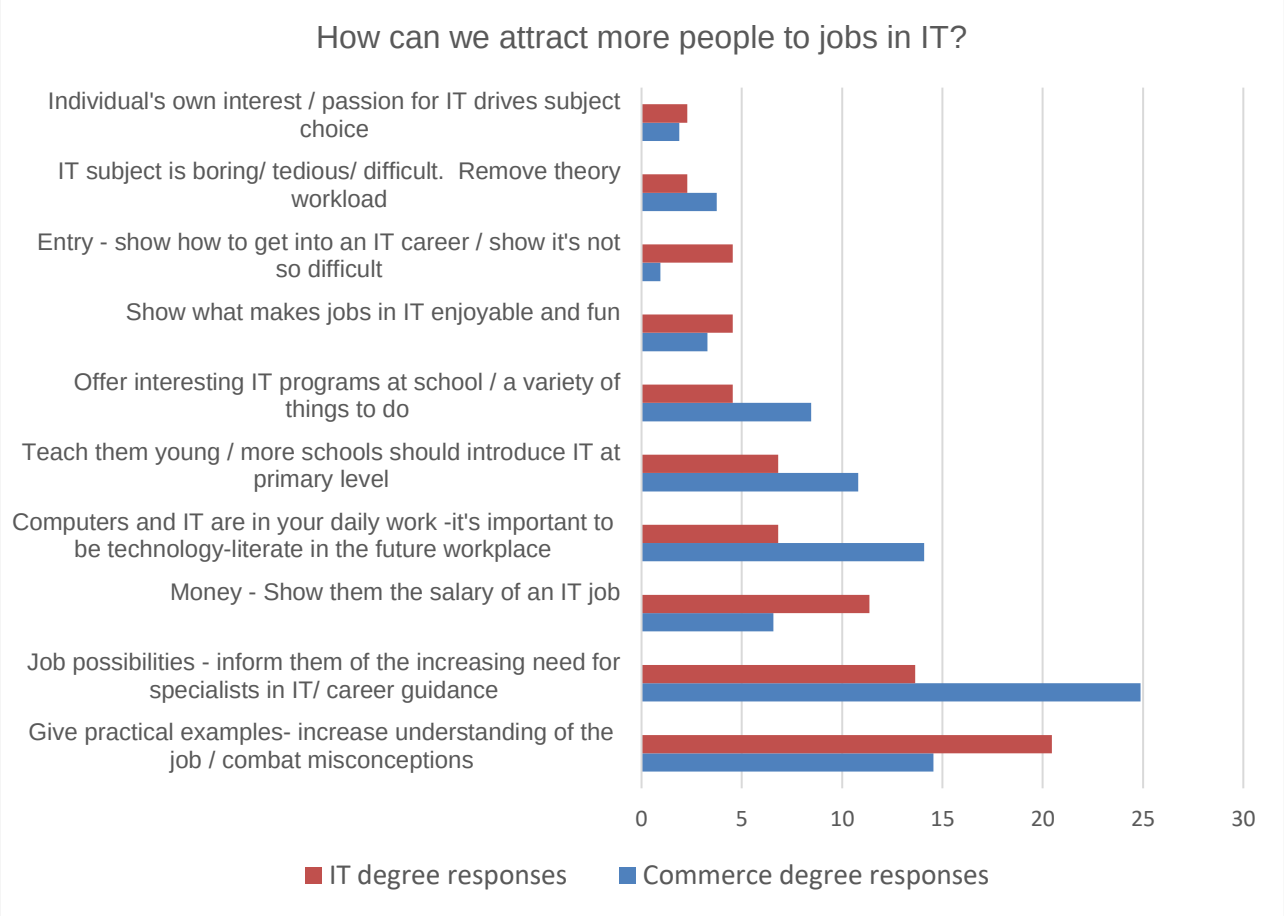


Figure 32: Two degree groups' responses to "How can we attract more people to Information Technology?"

Most commerce students called for career guidance or informing people of the need for IT workers in industry, while most of the IT students suggested that misconceptions of IT jobs should be combated by providing practical examples. The importance of a well-remunerated IT career was almost twice as important to the IT students than to the commerce students. The opposite was true for the content of the IT school subject, where commerce students were twice as likely to suggest that an interesting and varied school IT subject should be offered to young (primary level) scholars since they were going to be using computers regardless of their career choice. The IT students were also remarkably enthusiastic to show prospective entrants that getting into an IT career was not as difficult as generally thought. These responses can be collapsed into three categories:

Response	%*
Inform / educate about IT jobs	86,00
IT education (at school, after school)	23,00

The respondents overwhelmingly (86%) indicated that people need to be informed about IT career possibilities, as well as the nature of IT jobs:

- "Teach people about what IT is and to use it. People could like it but never know, because they barely know anything about IT"
- "Make people more aware of the career possibilities and make it seem less challenging"
- "They can be attracted if they realise how interesting it is rather than describing it as being complicated"
- "Make young pupils aware of the ubiquity of technology in every industry"
- "Importance of IT needs to be emphasised especially in SA"
- "Depends, coding is not the most popular or attractive degree. But it is the future"
- "Yes there are common misconceptions about IT. People should be better informed about the possibilities of IT. The world is evolving and I don't think IT is going away! "
- "It should be promoted more as people never really talk about jobs in IT"
- "Maybe if they were told about the fact that this world is changing towards being even more integrated with technology, and if they do not adapt they too will become obsolete"
- "State the number of job fields there are, and what one can accomplish in each job. People must know that jobs in IT will increase, but never lessen"
- "People should be made aware of the level of demand in IT field and the level of income received"
- "More exposure to it on different platforms and showing people and making them realise the influence of IT"
- "Seeing that the whole world is heading in that direction"

The respondents also provide their opinions on exposure to IT and the IT subject itself:

- "More awareness in terms of different options (jobs in IT). Make computer related subjects compulsory at school"
- "If IT can be included in each subject"

- "If the depth of IT was put out more at schools, as people just know technology exists but aren't really interested in the depths of it, so if there were means to make it more interesting, people would be attracted"
- "I think before we could talk about jobs in IT, it all starts from lower (primary) school and people get more interested to study further. But if we just start learning at university then we won't want anything to do with IT. It will seem difficult"

5.2.3.6 Content analysis of all four questions on the survey

The last step in Phase 3 consisted of identifying overarching themes from the content. Figure 33 illustrates the results of the coding process, from the codes which were created from the transcribed content, through categories to the themes identified.

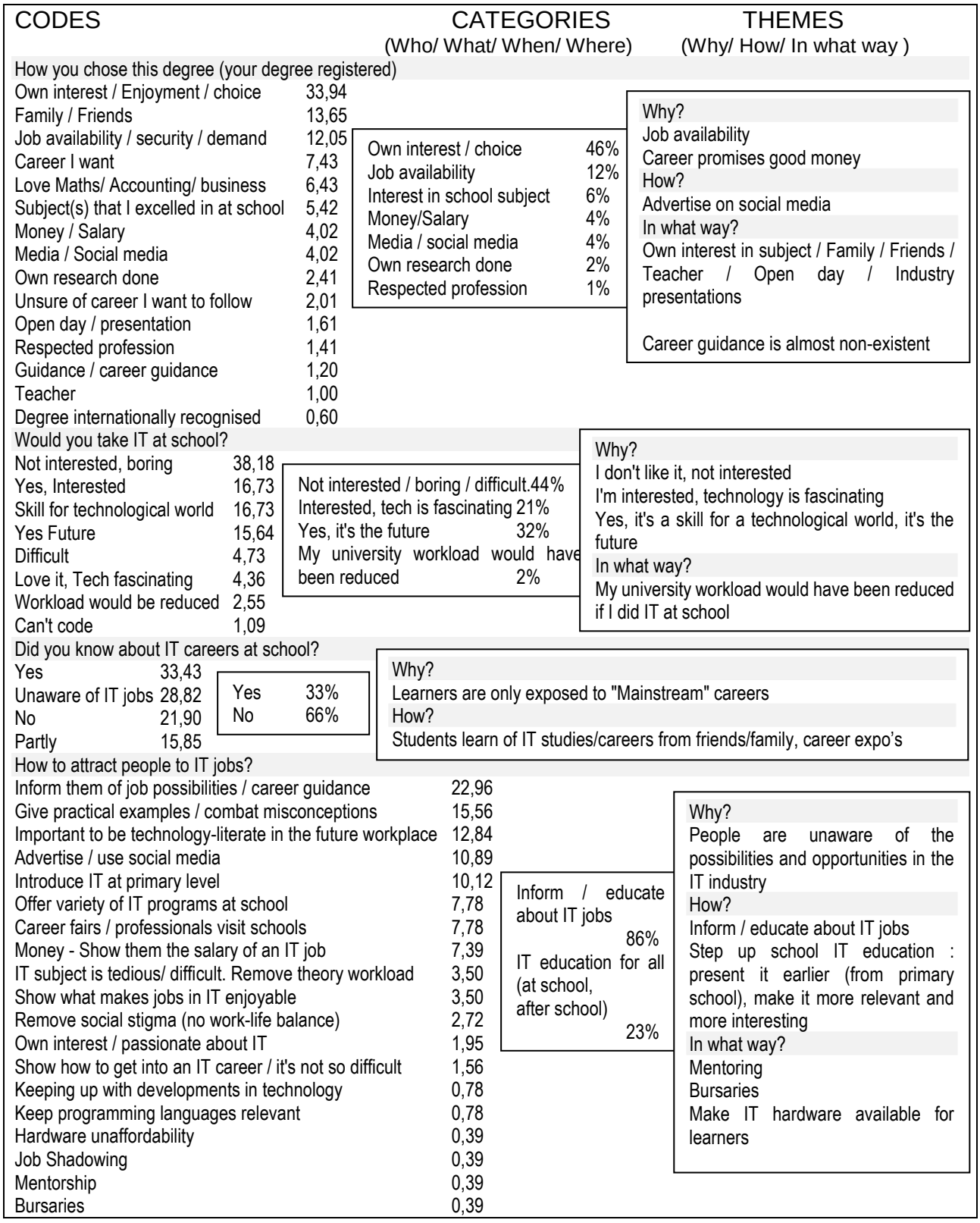


Figure 33: The organisation of coded meaning units into categories and themes

5.2.4 Integration of the three phases

The integration of quantitative and qualitative data in mixed methods research is an attempt at gaining a more complete understanding of an issue. The different types of data become interdependent in addressing the research questions of the study. Many studies collect both quantitative and qualitative data but do not integrate them. Data integration can be achieved in various ways, such as through study design, methods, interpretation or reporting.

This study integrates its data at the analytic and interpretation level. This means that the data of each of the phases is analysed and discussed in turn, and then followed by an attempt at integrating the different types of data. Integrating the data from the three phases in this study is performed using a joint display. Guetterman, Fetters and Creswell (2015) describe a joint display as a way to "integrate the data by bringing the data together through a visual means to draw out new insights beyond the information gained from the separate quantitative and qualitative results". It achieves a dual purpose in both generating new inferences and visually communicating them to the reader. The visual representation allows new insights to emerge and can occur through organising the findings in a table, figure, matrix or graph.

The joint display can be seen in Tables 33, 34 and 35. The tables each illustrate a construct of the underlying theoretical framework with the findings of the three phases combined. Three groups of respondents are reported on within the joint display. They are named according to their types of majors: Non-STEM majors, STEM majors (excluding IT) and IT majors. The respondents in each subsequent phase of this study, are subsets of the first phase. The respondents of the first phase consist of all UP first-years (excluding Medical and Engineering students). Respondents of the second phase are a subset of the first phase, being students from the Humanities, Natural Sciences and Engineering, Built Environment and IT faculties. Respondents of the third phase are all Informatics first-year students, from the Department Informatics. The sets of respondents are illustrated in Figure 34.

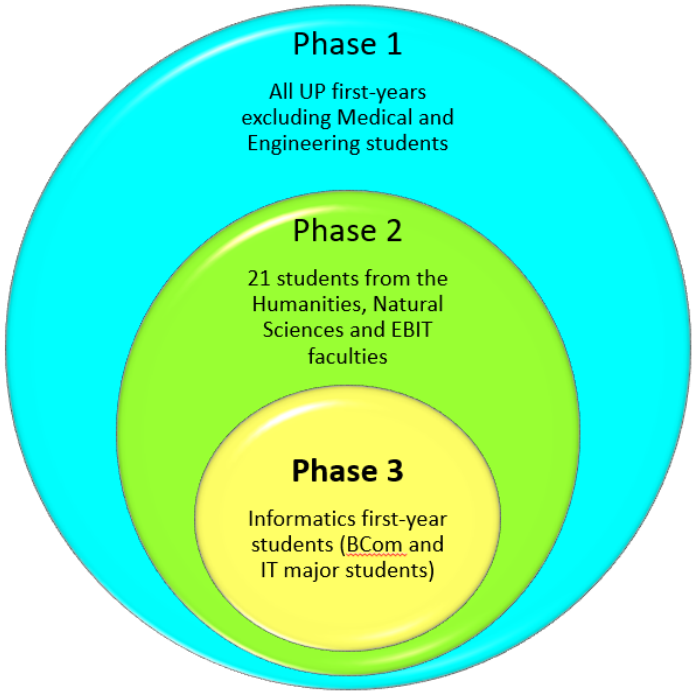


Figure 34: Venn diagram of respondents in the three phases

The joint display is organised in the form of a table with a column for each phase (See Tables 33, 34 and 35). There are three tables, one for each construct of the underlying framework of IT Study Choice. The findings for each item in the framework are summarised for each phase of the empirical study. Phase one is a quantitative study and therefore only statistically significant results are reported in this column. Phases two and three are both qualitative studies. Their quantified results have been recorded in the respective columns.

The findings of all three phases are displayed according to the underlying theoretical framework. Integration occurs by identifying congruences or discrepancies among the findings of the three phases for each item in the framework. The last column indicates the convergence of the results, or otherwise, by using the letters C, E or D. When integration of the results is not applicable (such as with demographic data) then a dash ("-") is displayed. The letters C, E or D respectively indicate confirmation, expansion or discordance. Confirmation indicates that the results from two or three phases confirm each other, which leads to greater credibility. Expansion indicates that results from two or three phases diverge and therefore enrich understanding of the phenomenon. Discordance indicates that the results from two or all three phases are inconsistent or contradict each other. To address

discordance, additional data might be gathered, the existing databases reanalysed to resolve differences, the validity of constructs might be challenged or explanations from theory sought (Fetters, Curry and Creswell, 2013; Bustamante, 2019).

Table 31: A cross-phase integration joint display for the *Personal data* construct of the underlying theoretical framework

		Phase 1 Online questionnaire	**Phase 2** Focus groups	**Phase 3** Open-ended questionnaire	*
Demographic data	Age	On average 17 years old			-
	Ethnicity	African & Asian females twice as likely to choose IT majors than White females	The ethnic majority in this study is Black African – 86%	-	-
	Gender	501 M, 974 F (2017) 1160 M, 2082 F (2018)	5 Males, 16 Females	107 Males,143 Females	-
	Nationality	-	19 South Africans, 2 Zimbabweans	-	-
	Race	Female students from the African and Asian population groups are twice as likely to choose an IT-related degree over a STEM degree, as compared to female students from the White population group	3 Whites,18 Black Africans	-	E
	Religion	-	Not requested and not volunteered	-	-
Lifestyle data	Spouse/partner	-	No respondents had spouses	-	-
	Children	-	No respondents had children	-	-
	Family background	Respondents' female-headed households per population group: 77% - African 40% - Coloured 20% - White 16% - Indian/Asian	Black African students from poorer households are expected to study something that will bring in money, which they have to send home for the first few years	Respondents are aware that jobs in IT have a high salary, and suggest that it be advertised as part of a strategy to attract people to IT	C
	Family work background	-	16 (76%) respondents' parents have tertiary education. All but 2 respondents' parents work full-time	-	-
	Socio-economics	STEM students more likely to have own room and own study table than IT students	Computing hardware unavailability hampers scholars' IT subject progress.	Scholars avoid the subjects IT and CAT when they cannot buy own computers	C
Intended career data	Intended career or job	-	People unaware of possible IT careers. Students follow advice of parents or family, who know only the "mainstream" careers.	People are unaware of the possibilities and opportunities in the IT industry	C
	Availability	-	33% (7) researched available studies/careers. Only 14% (3) aware	12% of students chose their career based on its availability	C

			of the many IT jobs available in industry		
	Security	-	Awareness of job security due to high demand for IT workers	12% aware of increasing need for IT workers	C
	Salary	-	Good remuneration is avidly sought and associated with high status careers	4% chose their career based on its salary	C
	Technical level	-	A direct correlation assumed between technical difficulty of major and possible job opportunities	Lack of awareness of the variety of IT jobs available	C
	Type of IT work		Information needed on the different types of IT work available	Information needed on the different types of IT work available	C

*CED - Confirm / Expand / Discordance or Not Applicable(-)

Table 32: A cross-phase integration joint display for the *Shaping & Influencing Factors* construct of the underlying theoretical framework

		Phase 1 Online questionnaire	Phase 2 Focus groups	Phase 3 Open-ended questionnaire	*
Personal characteristics	Education		All have matric with university admission. All attended good schools.	-	-
	School type		All attended co-ed schools. One attended a girl only school	-	-
	Curriculum and teaching	-	Teaching at schools were good. Some students advised against taking IT subject - it would negatively influence their APS score. Most received no career guidance counselling	Many had access to CAT and/or IT at school. Two respondents wished they had taken IT at school since it would have helped them in their studies.	C
	Degree registered	-	IT degrees have lower entry requirements than high-status degrees like Medicine & Engineering	-	-
	Interests & abilities	-	A wide variety of interests and abilities	6% displayed an interest in IT from early school years	C
	Aptitude	STEM students scored higher matric mathematics marks than IT students	Students choose subjects they excelled in at school	46% of students chose their major out of own interest	C
	Course workload	-	One female Computer Science major student said the struggle with coding is demoralising and alienating	Respondents are aware of the high IT subject workload	C
	Difficulty of IS major and IS curriculum	-	IT has a reputation for being a difficult subject.	Respondents shun IT due to its perceived difficulty	C
	Personality traits	Female STEM students scored higher on emotional stability than the female IT students. Male STEM students scored higher on	Two male IT students confessed to being highly asocial and introverted, and prefer to interact with technology and not people.	IT majors and IT workers are known for being “nerds” and “geeks” and not caring about work-family balance	C

		extraversion than male IT students			
	IT identity	Female IT students exhibit higher computer self-efficacy than STEM female students	95% reported positive IT identity. IT identity can change through programming experience.	44% of students are not interested in taking IT. 21% found it interesting and found technology fascinating.	C
	Subjective task value	-	All respondents feel they will make a difference in the workplace.	21% of respondents are interested in IT and feel technology is fascinating	C
	Goals and self-schemata	-	All live by the motto "Work hard to get a good job".	32% of respondents think they should take the school subject IT since IT is the future	C
Personal influences	Exposure to computing	-	Differs greatly among students.	-	-
	School ICT resource access	IT students have more access to computers at school than STEM students	Lacking, even in resource-rich schools. Scarce school IT resources are reserved for the IT students.	Respondents complain about lack of access to school IT resources	C
	Home ICT resource access	More male IT school learners played computer games at home than did male STEM students	One third of respondents had no home ICT access, but level of interest is more important than access	0.4% of respondents complain about lack of funds to purchase own IT resources	E
	Educational experiences	-	All respondents had good teachers. IT is seen as only for the clever students. The scarcity of good IT teachers is lamented. Bad school IT experiences lead to long-term negative attitudes toward IT	Respondents found school IT boring, tedious or difficult. They shun the IT theory. The programming languages taught are out-of-date. One respondent had an uninterested and ineffective teacher for IT	C
	Life experiences	-	Job shadowing helps identify a career	66% unaware of the variety and availability of IT jobs	-
	Social image beliefs	-	University degrees have status and "gives you a voice in the workplace"	Commerce and IT are respected professions	C
	Role models and mentors	-	Half of the respondents enjoyed support from family and friends	Mentorship is proposed for IT students	C
	Salient Referents	Male IT students were encouraged and guided toward IT studies significantly more than female STEM students	Parents and family members are relied upon to give support and advice	33% knew about IT jobs and learned about it from friends, family, career expo's and industry days.	C

*CED - Confirm / Expand / Discordance or Not Applicable(-)

Table 33: A cross-phase integration joint display for the *Environmental context* construct of the underlying theoretical framework

		Phase 1 Online questionnaire	**Phase 2** Focus groups	**Phase 3** Open-ended questionnaire	*
Cultural attitudes	Media, ICT stereotypes, Gender stereotypes	-	Media glamorise people in fictional jobs but can do more to educate public about realities in job market. ICT and gender stereotypes are becoming less salient	Stereotypes abound about males being IT specialists. Call for social media to be used in advertising the different opportunities in IT	E

	Attitude toward women	-	None.	-	-
Geographic data	Location	-	Rural areas are information-poor, especially regarding IT jobs. One student feels it is irrelevant because she gets her information from the internet.	-	-
	Population	-	None	-	-
	History	-	None	-	-
Economic data	Employment overall	-	Real unemployment is high	-	-
	Information economy employment	-	IT jobs are available in an economy which has high general unemployment	12% of respondents listed job availability as the reason they chose the major	C
Policy data	Relevant laws and policies	-	One respondent (female) was aware of preferential hiring of female engineers in industry. NSFAS bursaries given to working-class students	-	-

*CED - Confirm / Expand / Discordance or Not Applicable(-)

Most of the constructs in the underlying framework hold confirmatory results and no discordances were identified. Among those items not considered applicable in the integration matrix, responses to “Attitude to women” is conspicuously absent. This construct lies under “Environmental context” and “Cultural attitudes & values”. No respondents had any thoughts to contribute to any of the aspects “Attitude to women”, “Attitude to women at work” or “Attitude to women in IT”. The lack of responses can be interpreted as there being no negative attitudes experienced towards women working or working in IT.

Two expansions to knowledge were found. One regarded the Media (This construct lies under “Environmental context” and “Cultural attitudes & values”) Respondents suggested that advertising should happen on social media platforms rather than mainstream media. Another expansion to knowledge was found at the construct “School ICT resource access” under “Personal influences”. Responses indicated that access to school computers may neutralise the effects of a lack of home ICT access for those students taking the IT subject. This needs to be further investigated. However, two respondents remarked that the **level** of interest in computing technology is more important than having access to computing technology.

At the construct “IT identity”, a female student remarked that she would like to do IT “on the side”, meaning she will spend working hours on it. She is not prepared to spend her after-hours time on it, in the way that many males do it because IT is a hobby for them.

A finding emerged across the constructs “Socio-economics”, “Family background” and “Salary”: students from low income households strive for any career promising a high salary. African students have the largest percentage of female-headed households and therefore single parent households with a low income. Students from these households are expected to make monthly contributions to the household, in some cases even while being a student. For many students, the opportunity to qualify oneself for a lucrative career took precedence over many personal preferences, such as an individual’s interest in a subject or intended career. The surprising conclusion echoed by two IT students, is that they were enjoying their IT majors despite having known very little of the subject before arriving at university.

5.3 THE IT STUDY CHOICE FRAMEWORK IN CONTEXT

The findings from the Joint Display can be applied to the IT Study Choice Framework thereby contextualising the constructs in the framework, as illustrated in Figure 35: The Factors influencing IT Study Choice for female South African students.

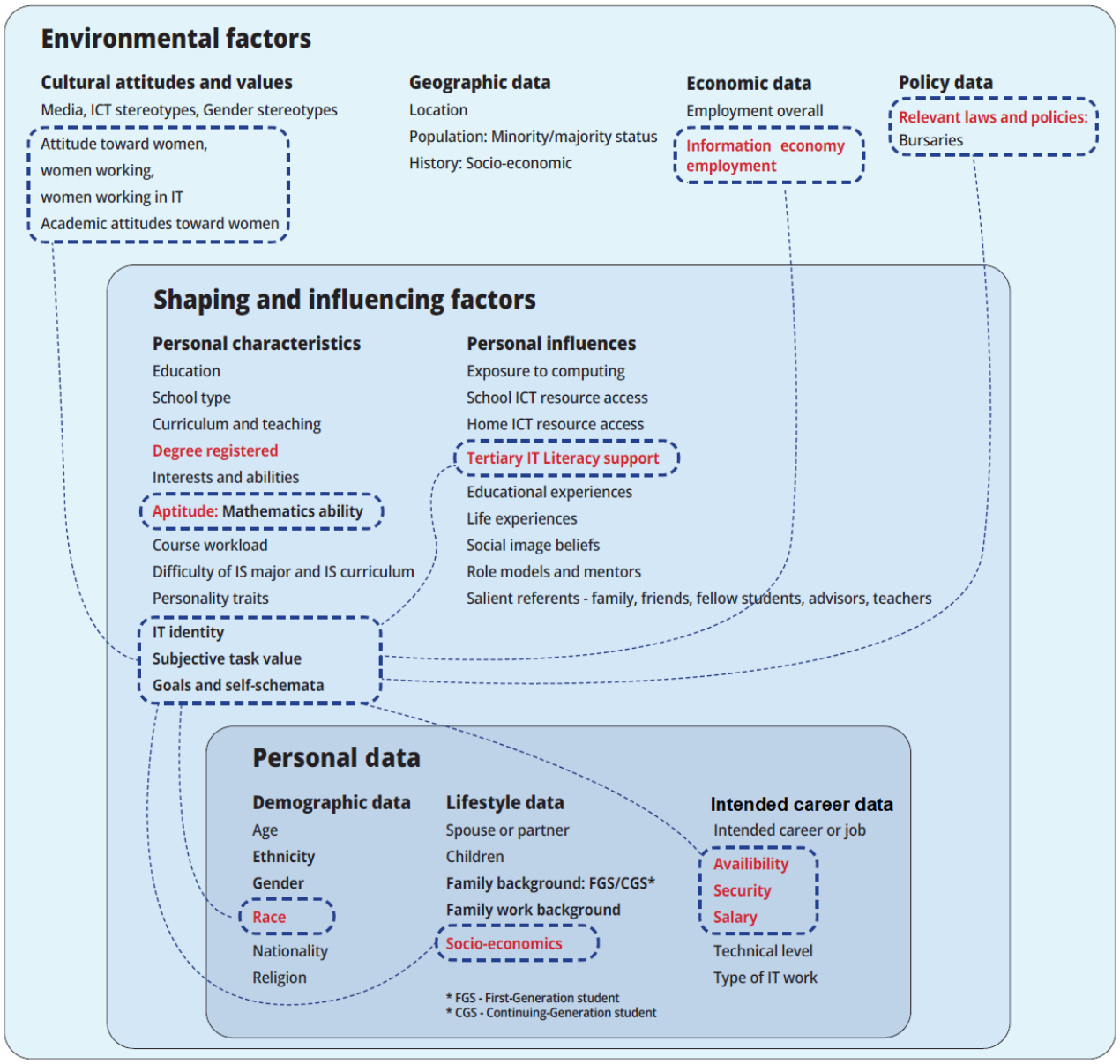


Figure 35: The Factors influencing IT Study Choice for female South African students

The findings of this study show that the factors that lead to a female South African student deciding to major in IT, are a convergence of a variety of influences and aptitudes. The students' mathematics aptitude is a prerequisite for their entry into STEM and IT studies, and is therefore indicated in the framework. However, the level of their mathematics aptitude is not further investigated because the entrance requirements ensure a predefined level of proficiency. The construct "Attitude toward women" has been proven to exert no influence on a female student's choice of IT major. It indicates that women experience no perceived

attitude barriers to participating in the workforce, IT or otherwise. The study shows that the students' choice of IT qualification is a combination of their race and ethnicity, socioeconomic status, mathematics aptitude, the availability of IT jobs and the support they receive at tertiary level to master the basics of information technology literacy.

5.4 CONCLUSION

This chapter presents the findings of all three phases of the mixed method study employed to determine the factors that influence first-year students to choose a major in IT, or conversely reject it. The findings of each phase are presented consecutively, after which the findings of all three phases are combined into a joint display showing how the data of each phase complement or disprove each other. The Framework of IT Study Choice is presented in context of the study and the pertinent factors indicated.

The next chapter provides a conclusion to this study by answering the research questions and reflecting on the findings.

6 CONCLUSION

This study was conducted to investigate the uptake of IT studies among South African female university students with a view to increasing their participation. In an attempt to address the many interrelated variables that influence career decisions, a theoretical framework was compiled to support the investigation. This chapter describes how the research questions were answered and presents a summary of the findings. Bourdieu's theory of practice is then applied to reflect on the findings. Finally, the researcher provides a summary of contributions and enumerates opportunities for future research.

6.1 SUMMARY OF FINDINGS

6.1.1 Review of research problem

A short review of the drivers behind this research is in order, as preamble for the discussion of the research questions.

The worldwide IT skills shortage is compounded by a lack of diversity in the workforce, and is acknowledged as a "wicked" problem. It is so called because it is difficult to solve due to contradictory and changing requirements, which are in themselves difficult to recognise. In a developing and highly unequal country such as South Africa, education is seen as a passport to a better life. This is sadly not always the case, as evidenced by the many unemployed graduates. The Information Technology industry however promises employment to suitably qualified entrants. While all prospective students who qualify for STEM degrees, also qualify to register for IT degrees, very few do so. Amongst those who do choose IT qualifications, the majority are men. To investigate the reasons behind the lack of female student interest in IT degrees, this study used a combination of approaches, both quantitative and qualitative. The approach to the investigation entailed building a firm theoretical foundation from which to cast the net wide and capture as wide a variety of salient factors as possible.

6.1.2 Answering the research questions

The first sub-question that supports the formulation of the theoretical framework in the main question is as follows:

> What is an appropriate framework to study the under-representation of females in tertiary IT qualifications?

Answering this question entailed two steps. The first step was to identify any contemporary frameworks that are available to study the under-representation of females in the IT industry. The second step was to identify how these frameworks may be harnessed to specifically address the career choice phase of the career lifecycle.

The search for an appropriate framework was purposefully kept to literature originating from IS journals. Focusing on the top IS journals allowed the researcher to take into consideration theories that had been successfully applied to the IS discipline, whether they be imported theories or native theories. The process was described in Chapter 3. By examining all explicitly theorised gender and IS studies in the top IS journals of the last 25 years, a contemporary gender-and-IS theory was identified to support investigations into the under-representation of females in the IT industry. This theory was proposed in 2002 and is at the time of writing, the most widely used theory for investigating the lack of diversity and the under-representation of females in the IT industry. The theory is called the Individual Differences Theory of Gender and IT (Trauth, 2002).

Among the gender-and-IS theories identified were two IT career choice theories, which were subsequently harnessed to allow the Individual Differences Theory of Gender and IT (IDT) to focus on the career choice phase of the IT career lifecycle. The resulting framework was called the IT Study Choice Framework (See Figure 35: The Factors influencing IT Study Choice for female South African students). The factors influencing an individual's decision to choose an IT major, are grouped into three main constructs: Personal data, Shaping and Influencing Factors and Environmental Factors.

The second sub-question that supports the formulation of the theoretical framework in the main research question is as follows:

> How might such a framework of IT study choice be applied to the uniquely South African context?

To answer this question, the IT Study Choice Framework was used as a basis for an online survey and subsequent follow-up interviews. The phases of the research are described in Chapter 4. The questionnaire was created with the aim of generating as comprehensive a dataset as possible of the factors in the framework. The subsequent interviews were used to elaborate on aspects that were difficult to determine using a questionnaire. The last qualitative phase identified the best avenue through which to inform role players of opportunities in the IT industry. The relevant factors and their interdependence are illustrated in Figure 34.

The major finding that emerged from this South African study was that female students from the African and Asian population groups were twice as likely to choose an IT-related degree over a STEM degree, as compared to female students from the White population group. The explanation can be found in the unique interaction of the various relevant constructs in the framework. This study found that female students who decided to register for an IT major exhibit a unique profile which is a combination of various factors in the framework. They are shown to be of Black, Indian or Coloured ethnicity and simultaneously of lower socio-economic status. This is linked to the two environmental factors “Population” and “History”, where certain parts of the country’s population were socio-economically disadvantaged during a phase of the country’s history. Subsequently these students possess little or no exposure to computers by the time they reach university. The construct “Relevant laws and policies” refers to the South African Government instating redress policies such as affirmative action and providing bursaries to enable deserving students to attain tertiary qualifications. Upon entering tertiary studies, these students become aware of IT employment opportunities in an otherwise constrained market, and decide to pursue IT studies. However, such a course of action is only possible when the tertiary institution offers

introductory IT courses (the item “Curriculum and teaching”), which the tertiary institution needs to put in place to equip students with IT literacy. These courses offer a firm footing from which the student is enabled to pursue certain IT qualifications. The construct “Degree registered” represents the qualification that the student qualifies for and registers for. The item “Difficulty of IS major and IS curriculum” indicate that these students carefully choose their IT major to avoid the overtly technical degrees such as Computer Science and Computer Engineering and focus on IT qualifications such as Informatics, GeoInformatics and Publishing.

The concept “Attitudes toward women working (in IT)” is a factor from the IT Study Choice Framework which is conspicuously absent in the discussion above. The absence of such attitudes, or prejudices, is a strong enabling factor. The Joint Display from Chapter 5 shows that an absence of responses over all three data collection phases to the “Attitude to women” construct indicates that the respondents were not aware of any negative attitudes toward women in the workplace, or indeed in the IT workplace. This sentiment was confirmed during the interview phase, where the researcher observed female students’ self-confidence and a lack of prejudice in any of the male students regarding female students studying IT. It is the combination of all the above-mentioned factors that underlie the increase of female students in IT studies.

6.1.3 Alignment of findings with literature survey

Three main findings emerged from the literature review, all of which are confirmed by this study. The first pertains to subject preference where males generally prefer the fields of mathematics and technology, while females prefer the humanities. This study confirmed it by descriptive statistics alone (see Table 20) where the numbers of female respondents taking technology-related degrees are half those taking non-technology related degrees, while the ratio for the male students is almost equal.

The second finding of the literature review, namely that participation in the IT workforce is constrained by a general lack of awareness of the field, is confirmed by the third phase of

this empirical study (Table 33) where two-thirds of the respondents indicated that they were not aware of available careers in IT.

The last finding of the literature review, that parent and teacher encouragement play a significant role for the female students, is statistically confirmed in the first phase of this empirical study. Statistically significant relationships were found for all respondents in terms of having a teacher's encouragement to do well at IT (Table 28). This is a double-edged sword since the findings show that the secondary school students interested in STEM fields were not encouraged to do IT at all. A similar situation exists with guidance counselling. In the 2018 survey; only a third of the STEM male students reported receiving guidance counselling on IT career possibilities.

6.1.4 New insights gained

Two expansions to knowledge were found. One regarded the construct "Media" where mainstream media are superseded by the widespread use of social media among students. Students felt that dissemination of any IT career-related information should happen on social media platforms rather than mainstream media. This finding flowed from the third phase of the empirical study that comprised a short questionnaire asking the students their opinion on the best way to inform secondary school learners of available careers in IT.

The second expansion to knowledge was found at the construct "Home ICT resource access". Responses indicated that even though most students had home IT access, an active interest in computing technology is more important than access to computing technology.

6.2 EVALUATION OF THE FRAMEWORK'S CONTRIBUTION

Three aspects may be considered while evaluating the contribution of the IT Study Choice Framework to the body of knowledge.

- Theoretical contribution: The Individual Differences Theory of Gender and IT (IDT) formed the theoretical base of the study. The IT Study Choice Framework took the IDT and focused it on the career choice phase of an individual's IT career. This study identified specific factors that play a role and how they uniquely interact in the context of the country where the study was performed.

- Methodological contribution: Studies on gender and IT generally follow a qualitative approach to investigation. Various calls have been made for a plurality of approaches to investigate the phenomenon. This study answers that call by employing a mixed methods approach consisting of three phases.

- Practical contribution: This study confirms that careers in information technology are perceived as lower in social status than traditional careers in law and medicine, in the context of the country where the study was performed. Yet it found that this perception may be changed by actively informing parents and students of the opportunities offered in the IT industry, and it identified that social media is the most effective platform to realise such communication.

6.3 CONCLUDING REMARKS

Bourdieu's theory of practice can be applied to the study and used to interpret the results. The context, or "logic of practice", as applied to the current study is enacted by the students (see Table 34: Bourdieu's Theory of Practice as applied to this study). They construct their social reality (the major they pursue) at the university where they are registered. Their field consists of all the available majors at the institution and their agency is exercised through their decision to pursue any one of these majors. There are various forms of capital. Embodied cultural capital refers to the accumulation of cultural capital in the embodied state, personally by the investor. The acquisition cannot be done second-hand. An example in this case is an individual who acquires a university degree. Technical capital, in the case of IT majors, is the skill set specific to engagement with modern computing technology. Symbolic capital is prestige associated with cultural capital such as a STEM degree. Economic capital can be seen as the possession of material wealth or the access to it, such as being able to afford a

university degree, either with savings or being awarded a bursary. Enrolling for majors that promise above-average salaried careers is an important step toward acquiring economic capital.

Table 34: Bourdieu's Theory of Practice as applied to this study

	The logic of practice	Applied to this study
	The relationship between social actors constructing their social reality and the social structure both constraining and enabling their agency.	The actors are the students and the social reality is the qualifications they pursue.
Field	The objective social relations and structures that govern the actions of actors in social situations.	The field of available majors at tertiary institutions.
Habitus	Human agency, or the various forms of behaviour and dispositions that people acquire through acting in society. Habitus is not fixed, but in constant negotiation with the world.	Students pursuing STEM or IT majors at tertiary institutions.
Capital	Capital forms the foundation of social life, dictating the individual's position within the social order – more capital implies a more powerful position in society, economically as well as culturally.	The prestige (symbolic capital) of a university degree, accumulating technical capital which promises a lucrative career (economic capital).

Bourdieu argued that the ruling classes in a society have power not only in terms of wealth but also in terms of cultural assets. He held that the children of ruling-class parents are likely to exhibit behaviour and attitudes that ensure that they succeed in education as well as the larger society, thus perpetuating their position in society. He held the opinion that much of a society's education system assess people not on merit or effort, but on the extent to which they exhibit ruling-class habitus.

When we use a Bourdieusian lens to examine the influence of cultural and economic capital on a (female) individual's choice of an IT major in a developing country such as South Africa, we see two distinct groups, each with their own types of capital. The historically advantaged students (mostly those of White ethnicity) exercise agency by choosing STEM qualifications, some of which have higher entrance requirements and promise an affectively, cognitively and financially rewarding career. Students from historically disadvantaged groups, in this case students of Black, Indian and Coloured ethnicities, choose IT, based not primarily on subject interest but on the promise of a stable income. This pragmatic choice stands them

in good stead in the context of a developing country, where job opportunities are scarce and state support is inadequate.

These findings indicate that Bourdieu's argument regarding the perpetuation of social status via education does not hold in the case of information technology studies. In the IT field, students are assessed solely on merit and not on cultural habitus. The IT field is unique in terms of its relative youth and subject content, and cannot be compared to the traditionally disciplines of Medicine and Law. Choosing a qualification in IT is open to any interested and suitably talented individual, irrespective of race, gender or socio-economic status.

6.4 SUMMARY OF CONTRIBUTIONS

This study addresses the need for investigating the variety of factors that can explain women's under-representation in information technology. It clearly demonstrates the importance of considering a range of environmental and individual influences as well as how they intersect in attempting to understand the phenomenon. Existing investigations consider a limited number of variables such as gender and ethnicity while calling for a wider net to be thrown. This study contributes to the literature by considering the intersection of personal data such as race/ethnicity and socio-economic status, influencing factors such as exposure to computing, curriculum and teaching, and overarching environmental aspects such as population, history, laws, policies and employment opportunities in the information economy.

Various studies have called for further research into specific factors. Lehman et al. (2017) called for investigations into variables such as students' prior experience with computing and their high school IT experiences. This mixed method study was able to shed light on these aspects by recording the respondents' school IT experiences. The scarcity of good IT teachers was a general concern, and even well-resourced schools could only provide ICT access to IT students and not all interested parties. School IT was found to be tedious and difficult, an aspect that causes long-term negative attitudes to IT. Al-Qirim *et al.* (2017) called for research on the personality traits of IT students and how they vary from non-science-

based students. This study found two statistically significant findings regarding students' personality profiles. The first significant difference found between female STEM and IT students were that female STEM students scored significantly higher on the emotional stability trait than female IT students. No studies could be found that performed a similar exercise between IT and non-IT respondents. The second significant difference found was between male STEM and IT students where the male STEM students scored significantly higher on extraversion than the male IT students.

To the best of our knowledge, this is the first study that investigates and contrasts the factors that influence first-year students to register for either IT-related degrees or STEM degrees.

Lastly, the study contributes to the limited literature on the application of Bourdieu's theory of practice to the information technology field, and, in particular, how technical proficiency confers social and economic power to the individual.

6.5 RESEARCH LIMITATIONS AND FUTURE RESEARCH

This research, having been conducted by one individual, had certain limitations:

- research was conducted at one university only, and although the student population of this university is representative of the country's population, it would be advisable to conduct the same study at more than one other universities, preferably in other provinces of the country. This could confirm the findings regarding the intersection between ethnicity and socio-economic status, and would also allow the compilation of the gender-ethnic distribution of student registrations per qualification; and
- another limitation was the number of interviews. Although theoretical saturation had been reached before the interviews had all been concluded, there is a small number of females enrolled for IT degrees in this sample. A larger sample of interview respondents would imply a larger number of female IT students who may be approached for interviews.

Based on the conclusions made in this study, a number of recommendations can be made:

- coding can be introduced into primary school curricula, with attention given to the fact that it be first and foremost an enjoyable activity.
- industry can be informed that their time spent at school career days are an excellent investment.
- it is necessary to determine how best to use social media to disseminate information on available IT careers and opportunities, including precise job descriptions, to educate and inform both students and their parents or guardians.

6.6 THE LAST WORD

After all had been said and done, one could ask if the IT girls had made the right decision. The happy ending is that the students were enjoying the major into which they “fell”, even though by their own admission, they knew very little about information technology before arriving at university.

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APPENDICES

APPENDIX A: QUESTIONNAIRE CONSTRUCTS AND QUESTIONS

The dependent variable is the student's degree registered for : 5.1.

Otherwise, any possible Informatics subjects registered for : 5.2.

Q5.1 What degree are you registered for at UP ? Please select Faculty (1) Please select Degree (2)	Q5.2 Are you enrolled for any of the following subjects ? (Please check all that apply) ▢ INF (1) ▢ COS (2) ▢ INL (3) ▢ IMY (4)

IDT structure	Aspects included in questionnaire	Question number
Personal data		
Demographics	Age	(Not asked in questionnaire) Deduct from Q46 Year of study? matric age 18 +(year of study) First year student average Age = 19?
	Ethnicity / Race	(Not asked in questionnaire) Closest approximation : Q 3.2 Home language Afr/Eng/African language
	Gender	Q2.1 What is your gender? Male Female Other
	Nationality	Q2.2 Are you a South African citizen? Yes / No Q2.3 Which country's passport do you hold? A South African country (e.g. Namibia, Swaziland, Lesotho) An African country (e.g. Algeria, Nigeria, Angola, Zimbabwe etc) A European country (e.g. United Kingdom, France, Germany etc) An Asian country (e.g. Russia, China, India, Korea, Indonesia etc) A North American country (e.g. United States, Mexico, Canada, Hawaii etc) A South American country (e.g. Brazil, Argentinia, etc) Australia or New Zealand Another country
Lifestyle data	Spouse/partner	Q3.13 Which of the following best describes your current relationship status?

		Single / In a relationship / Married / Other
	Children	Q3.14 Do you have children of your own? Yes / No
	Family background	Q3.1 Is your childhood home in :
		A City?
		A Suburb?
		A Township?
		A Town?
		A Rural area?
		Other
		Q3.3 Who mainly looked after you in your childhood home?
		Father and Mother / Father / Mother / Another Family Member / A Guardian / Other
		Q3.4 Which education type best describes your father's education?
		Q3.5 Which education type best describes your mother's education?
		Q3.6 Which education type best describes the education of the person who looked after you?
		Did not attend school / Primary school / Secondary (High) school/ Tertiary / College / University / Don't know
	Family work background	Q3.7 Which employment type best describes your father's employment?
		Q3.8 Which employment type best describes your mother's employment?
		Q3.9 Which employment type best describes the employment of the person who looked after you?
		Not Working / Working full-time / Working part-time / Other / Don't know
		Q3.10 Please indicate your agreement with the following statements : Agree / Disagree
		My mother was a housewife
		My mother was a professional working woman
	Socio-economics	Q3.12 In your childhood home
	Home ICT access	Did you have a computer at home?
		Did you have your own room?
		Did you have a study table / desk you could use yourself?
		Did you have an internet connection?
		Did you work on the computer at home?
		Did you play computer games at home?
Workplace data	-	-
		-
Shaping & Influencing factors		

Personal characteristics	Education School type	Q4.1 The school where you completed your matric was a: Co-ed school (Both boys and girls) Girls only school Boys only school Home school
	Curriculum and teaching	Q4.2 Which of the following subjects did you take? (Please check all that apply) Mathematics / Mathematical Literacy / Advanced Programme Mathematics Q4.5 Please check Yes or No for each question Yes / No a. Did your school offer the subject Information Technology (IT)? b. Did your school offer the subject Computer Applications Technology (CAT)? Q4.6 Did you take the subject Information Technology (IT)? Q4.7 Did you take the subject Computer Applications Technology (CAT)?
	Interests & abilities	Sports Arts & Crafts Computer Activities Culinary Pursuits Cultural Arts Nature Music Literature Socializing Travel Other Q4.3 What was your matric mark for Mathematics? (0-100%) Q4.4 Which of the following subject types did you enjoy the most? (Please check all that apply) Languages Mathematics and Sciences (These include Life Sciences, Physical Sciences, computer Sciences and Mathematical Sciences) Business studies (These include Accounting and Economics) All Other Humanities and Social Sciences (These include Arts, Music, Geography, History and the Social Sciences) Q4.8 Did you enjoy your IT subject?
	Genuine interest in IS field Aptitude, course workload, difficulty of IS major and IS curriculum	
	Personality traits	Q6.2

	IT identity	Q5.3 Please indicate your agreement with the following statements : I am happy using a computer in my work or studies It is easy for me to use a computer for work or play I respect my male lecturers I respect my female lecturers I believe women in IT is just as effective as men in IT
	Interpretations of experiences/ Social image beliefs, Personal image beliefs	Q5.3 Please indicate your agreement with the following statements : I am happy using a computer in my work or studies It is easy for me to use a computer for work or play I respect my male lecturers I respect my female lecturers I believe women in IT is just as effective as men in IT Q5.4 Why did you decide not to take any Information Technology modules? (Please check all that apply to you) I prefer to study something else. I am not good with computers. I did not know what Information and Communications Technology meant. My parents suggest that an alternative qualification would be better for me. My friends think that alternative subjects are better and I listened to them. I think that Information Technology courses are more difficult than other courses. Majoring in Information Technology would make me look like a geek. I hate computers and I want as little to do with them as possible Q5.5 Do you have any reasons you chose not to major in Information Technology? (Please check all the reasons that apply to you) I do not think there is good job security in the Information Technology field. I think the Information Technology jobs' work hours are long. I do not think I can get a job in the Information Technology field when I graduate. I do not think that Information Technology is a good career choice for me.
Personal influences	Exposure to computing School ICT resource access	Q4.9 Did you have access to a computer at school? Q4.10 Did you work on a computer at school? Q4.11 Did your school have a computer lab? Q4.12 Did you make use of the computer lab? Q4.13 What did you use the school computer for? (Please check all that apply) School work / Games/ IT subjects / Other

	Educational experiences Teacher(s) Life experiences Role models & mentors Salient Referents – family, friends, fellow students, advisors, professors	Q3.11 Please indicate your agreement with the following statements : My father / mother / guardian encouraged me to do well at school My father / mother / guardian encouraged me to choose any occupation I liked Q4.14 Please indicate your agreement with the following statements : My teacher encouraged me to do well at mathematics My teacher encouraged me to do well at IT My guidance counsellor helped me in my university study choice My guidance counsellor told me about IT work possibilities
Environmental context		-
Cultural attitudes & values	Attitude toward women, women working, women working in IT : Media, ICT stereotypes, Gender stereotypes	Question 5.3
	Academic attitudes toward women (in general, in IT)	Question 5.3
Geographic data	Location Population History	Question 2.4 Which province are you from? Eastern Cape Free State Gauteng KwaZulu-Natal Limpopo Mpumalanga North West Northern Cape Western Cape Q2.3 Which country's passport do you hold? - -
Economic data	Employment overall Information economy employment	- -
Policy data	Relevant laws and policies	-

APPENDIX B: QUESTIONNAIRE

ICT Study Choice Questionnaire

Introduction

Q1.1 Dear Participant

Thank you for taking your time to complete this questionnaire. It is greatly appreciated. My name is Nita Mennega. I'm a PhD student from the Department of Informatics at the University of Pretoria. The purpose of this study is to gain insight into the way study choices are made by first-year university students, with particular reference to Information Technology studies. "Information Technology" or "I.T." refers to anything related to computing technology, such as networking, hardware, software, the Internet, or the people that work with these technologies. Since we live in the "information age," information technology has become a part of our everyday lives. Even if your primary career choice is not IT, expertise in computing will help you in your job. This questionnaire asks about yourself as an individual, about your life before coming to university, and also about anything or anyone else who might have had an influence on your study choices. It also asks how you feel about computer studies in general. The information obtained from you and other students will help to identify the best ways to increase the number of students in computing disciplines in South Africa, and enable many more to participate in the ICT economy. Please note the following: This is an anonymous questionnaire which will take approximately 10 minutes. The information supplied will be treated as strictly confidential. Your participation in this study is very important to us. You may, however, choose not to participate or stop at any given time, should you feel uncomfortable. There will be no negative consequences. Please answer the questions as honestly as possible. There is no right or wrong answer. The results of the study will be used for academic purposes and may be published in an academic journal. We can provide you with a summary of our findings on request. Please contact my study leader, Prof. C de Villiers (012 420 3798) or carina.devilliers@up.ac.za if you have any questions or comments regarding the study. By selecting the "Yes" option I hereby voluntarily grant my permission for participation in this **anonymous** survey. The objective has been explained to me and I understand it. I

understand my right to choose whether to participate in the research project and that the information provided will be handled confidentially. I am aware that the results of the survey may be used for publication.

○ Yes No

Skip To: End of Survey If Dear Participant .. = No

End of Block: Introduction

Background Information

Q2.1 What is your gender? Male / Female / Other

Q2.2 Are you a South African citizen? Yes / No

Display This Question: If Are you a South African citizen? = No

Q2.3 Which country's passport do you hold?

A South African country (e.g. Namibia, Swaziland, Lesotho) (1)

An African country (e.g. Algeria, Nigeria, Angola, Zimbabwe etc) (2)

A European country (e.g. United Kingdom, France, Germany etc) (3)

An Asian country (e.g. Russia, China, India, Korea, Indonesia etc) (4)

A North American country (e.g. United States, Mexico, Canada, Hawaii etc) (5)

A South American country (e.g. Brazil, Argentinia, etc) (6)

Australia or New Zealand (7)

Another country (8)

Display This Question: If Are you a South African citizen? = Yes

Q2.4 Which province are you from?

Eastern Cape

Free State

Gauteng

KwaZulu-Natal

Limpopo

Mpumalanga

North West

Northern Cape

Western Cape

End of Block: Background Information

Family Background

Q3.1 Is your childhood home in :

- A City?
- A Suburb?
- A Township?
- A Town?
- A Rural area?
- Other

Q3.2 What was the primary language spoken in your childhood home?

- Afrikaans
- English
- Ndebele
- Northern Sotho
- SeSotho
- Swazi
- Tsonga
- Tswana
- Venda
- Xhosa
- Zulu
- Another first language

Q3.3 Who mainly looked after you in your childhood home?

- Father and Mother
- Father
- Mother
- Another Family Member
- A Guardian
- Other

Display This Question:

If Who mainly looked after you in your childhood home? = Father

Or Who mainly looked after you in your childhood home? = Father and Mother

Q3.4 Which education type best describes your father's **education**?

- Did not attend school
- Primary school
- Secondary (High) school
- Tertiary / College / University
- Don't know

Display This Question:

If Who mainly looked after you in your childhood home? = Mother

Or Who mainly looked after you in your childhood home? = Father and Mother

Q3.5 Which education type best describes your mother's **education**?

- Did not attend school
- Primary school
- Secondary (High) school
- Tertiary / College / University
- Don't know

Display This Question:

If Who mainly looked after you in your childhood home? = Another Family Member

Or Who mainly looked after you in your childhood home? = A Guardian

Or Who mainly looked after you in your childhood home? = Other

Q3.6 Which education type best describes the **education** of the person who looked after you?

- Did not attend school
- Primary school
- Secondary (High) school
- Tertiary / College / University

- Don't know

Display This Question:

If Who mainly looked after you in your childhood home? = Father

Or Who mainly looked after you in your childhood home? = Father and Mother

Q3.7 Which employment type best describes your father's **employment**?

- Not Working
- Working full-time
- Working part-time
- Other
- Don't know

Display This Question:

If Who mainly looked after you in your childhood home? = Mother

Or Who mainly looked after you in your childhood home? = Father and Mother

Q3.8 Which employment type best describes your mother's **employment**?

- Not Working
- Working full-time
- Working part-time
- Other
- Don't know

Display This Question:

If Who mainly looked after you in your childhood home? = Another Family Member

Or Who mainly looked after you in your childhood home? = A Guardian

Or Who mainly looked after you in your childhood home? = Other

Q3.9 Which employment type best describes the **employment** of the person who looked after you?

- Not Working
- Working full-time
- Working part-time

- Other
- Don't know

Display This Question:

If Who mainly looked after you in your childhood home? = Mother

Or Who mainly looked after you in your childhood home? = Father and Mother

Q3.10 Please indicate your agreement with the following statements : Agree / Disagree

- My mother was a housewife
- My mother was a professional working woman

Q3.11 Please indicate your agreement with the following statements : Agree / Disagree

- My father / mother / guardian encouraged me to do well at school
- My father / mother / guardian encouraged me to choose any occupation I liked

Q3.12 In your childhood home - Please check Yes or No

- Did you have a computer at home?
- Did you have your own room?
- Did you have a study table / desk you could use yourself?
- Did you have an internet connection?
- Did you work on the computer at home?
- Did you play computer games at home?

Q3.13 Which of the following best describes your current relationship status?

- Single
- In a relationship
- Married
- Other

Q3.14 Do you have children of your own? Yes / No

End of Block: Family Background

School Background

Q4.1 The school where you completed your matric was a:

- Co-ed school (Both boys and girls)
- Girls only school
- Boys only school
- Home school

Q4.2 Which of the following subjects did you take? (Please check all that apply)

- Mathematics
- Mathematical Literacy
- Advanced Programme Mathematics

Display This Question:

If Which of the following subjects did you take? (Please check all that apply) = Mathematics

Or Which of the following subjects did you take? (Please check all that apply) = Mathematical Literacy

Q4.3 What was your matric mark for Mathematics? (0-100%)

Q4.4 Which of the following subject types did you enjoy the most? (Please check all that apply)

- Languages (1)
- Mathematics and Sciences (These include Life Sciences, Physical Sciences, computer Sciences and Mathematical Sciences) (2)
- Business studies (These include Accounting and Economics) (3)
- All Other Humanities and Social Sciences (These include Arts, Music, Geography, History and the Social Sciences) (4)

Q4.5 Please check Yes or No for each question

- Did your school offer the subject Information Technology (IT)?
- Did your school offer the subject Computer Applications Technology (CAT)?

Display This Question:

If Please check Yes or No for each question = Did your school offer the subject Information Technology (IT)?

Q4.6 Did you take the subject Information Technology (IT)? Yes / No

Display This Question:

If Please check Yes or No for each question = Did your school offer the subject Information Technology (IT)?

Q4.7 Did you take the subject Computer Applications Technology (CAT)?)? Yes / No

Display This Question:

If Did you take the subject Information Technology (IT)? = Yes

And Did you take the subject Computer Applications Technology (CAT)? = Yes

Q4.8 Did you enjoy your IT subject? Yes / No

Q4.9 Did you have access to a computer at school? Yes / No

Display This Question:

If Did you have access to a computer at school? = Yes

Q4.10 Did you work on a computer at school? Yes / No

Q4.11 Did your school have a computer lab? Yes / No

Display This Question:

If Did your school have a computer lab? = Yes

Q4.12 Did you make use of the computer lab? Yes / No

Display This Question:

If Did you make use of the computer lab? = Yes

Or Did you work on a computer at school? = Yes

Q4.13 What did you use the school computer for? (Please check all that apply)

- School work
- Games
- IT subjects
- Other

Q4.14 Please indicate your agreement with the following statements :

(Not Applicable / Never / Occasionally / A moderate amount / A great deal)

- My teacher encouraged me to do well at mathematics
- My teacher encouraged me to do well at IT
- My guidance counsellor helped me in my university study choice
- My guidance counsellor told me about IT work possibilities

Intended Study and Workplace

Q5.1 What degree are you registered for at UP ?

Please select Faculty (1)

Please select Degree (2)

Q46 What is your year of study?

- 1st year (1)
- 2nd year (2)
- 3rd year (3)
- 4th year (4)

Q5.2 Are you enrolled for any of the following subjects ? (Please check all that apply)

- INF
- COS
- INL
- IMY

Q5.3 Please indicate your agreement with the following statements :

(Strongly disagree / Disagree / Somewhat Disagree / Neither agree nor disagree / Somewhat agree / Agree / Strongly agree)

- I am happy using a computer in my work or studies
- It is easy for me to use a computer for work or play
- I respect my male lecturers
- I respect my female lecturers
- I believe women in IT is just as effective as men in IT

Display This Question: If Are you enrolled for any of the following subjects ? (Please check all that apply) != INF And != COS And!= INL And!= IMY

Q5.4 Why did you decide not to take any Information Technology modules? (Please check all that apply to you)

- I prefer to study something else.
- I am not good with computers.
- I did not know what Information and Communications Technology meant.
- My parents suggest that an alternative qualification would be better for me.
- My friends think that alternative subjects are better and I listened to them.
- I think that Information Technology courses are more difficult than other courses.
- Majoring in Information Technology would make me look like a geek.
- I hate computers and I want as little to do with them as possible

Display This Question: If What degree are you registered for at UP ?

!= Faculty of Economic and Management Sciences

~ BCom Informatics Information Systems

And ~ BEng Computer Engineering

And ~ BEng Computer Engineering ENGAGE

And ~ BEng Electronic Engineering

And ~ BEng Electronic Engineering ENGAGE

And ~ BIS Information Science

And ~ BIS Multimedia

And ~ BIS Publishing

And ~ BSc Computer Science

And ~ BSc Information and Knowledge Systems

Q5.5 Do you have any reasons you chose not to major in Information Technology ? (Please check all the reasons that apply to you)

- I do not think there is good job security in the Information Technology field.
- I think the Information Technology jobs' work hours are long.
- I do not think I can get a job in the Information Technology field when I graduate.
- I do not think that Information Technology is a good career choice for me.

Display This Question: If What degree are you registered for at UP ?

= Faculty of Economic and Management Sciences

~ BCom Informatics Information Systems

Or ~ BEng Computer Engineering

Or ~ BEng Computer Engineering ENGAGE

Or ~ BEng Electronic Engineering

Or ~ BEng Electronic Engineering ENGAGE

Or ~ BIS Information Science

Or ~ BIS Multimedia

Or = Faculty of Engineering, Built Environment and Information Technology

~ BIS Publishing

Or ~ BIT Information Technology

Or ~ BSc Computer Science

Or ~ BSc Information and Knowledge Systems

Q5.6 What made you choose IT studies? (Please check all the reasons that apply to you)

- I like to work on a computer.
- I enjoy gaming
- There are many jobs available in the Information Technology field.

End of Block: Intended Study and Workplace

Your interests, opinions and values

Q6.1 What are your interests? (Please check all those that apply to you)

Sports
Arts & Crafts
Computer Activities
Culinary Pursuits
Cultural Arts
Nature
Music
Literature
Socializing
Travel
Other

Q6.2 Here are a number of personality traits that may or may not apply to you. Please indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

(Strongly disagree / Disagree / Somewhat disagree / Neither agree nor disagree / Somewhat agree / Agree / Strongly agree)

Extraverted, enthusiastic

Critical, quarrelsome

Dependable, self-disciplined

Anxious, easily upset

Open to new experiences, complex

Reserved, quiet

Sympathetic, warm

Disorganized, careless

Calm, emotionally stable

Conventional, uncreative

End of Block: Your interests, opinions and values

General

Q7.1 I would like to get more details about events in your life leading up to your study choice. If you are willing to participate in a follow-up interview on the topics covered in this survey, please provide information for the best way to contact you. Your participation in this research is confidential.

Your contact email or telephone number : _____

APPENDIX C: ETHICS COMMITTEE APPROVALS

Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en Inligtingtegnologie / Lefapha la Boetšenere, Tikologo ya Kago le Theknolotši ya Tshedimošo

Reference number: EBIT/71/2017 2 August 2017

Mrs RA Mennega
Department of Informatics
University of Pretoria
Pretoria
0028

Dear Mrs Mennega,

FACULTY COMMITTEE FOR RESEARCH ETHICS AND INTEGRITY

Your recent application to the EBIT Research Ethics Committee refers. Conditional approval is granted.

This means that the research project entitled "Understanding the motivations of female South African university students to study information technology" is approved under the strict conditions indicated below. If these conditions are not met, approval is withdrawn automatically. The applicant is not required to submit an updated application.

Conditions for approval

1. Possible later interviews may only use questions that were cleared in the present approval. If new questions are asked during interviews, an amendment to the present application needs to be submitted.
2. The present application will require the answering of many personal questions (that have been motivated). It is especially important to explain to participants why these personal questions are asked and what will be done with the answers.

This approval does not imply that the researcher, student or lecturer is relieved of any accountability in terms of the Code of Ethics for Scholarly Activities of the University of Pretoria, or the Policy and Procedures for Responsible Research of the University of Pretoria. These documents are available on the website of the EBIT Ethics Committee.

If action is taken beyond the approved application, approval is withdrawn automatically.

According to the regulations, any relevant problem arising from the study or research methodology as well as any amendments or changes, must be brought to the attention of the EBIT Research Ethics Office.

The Committee must be notified on completion of the project.

The Committee wishes you every success with the research project.

Prof JJ Hanekom

Chair: Faculty Committee for Research Ethics and Integrity
FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

A second approval was sought from the ethics committee for the second web survey, as it was found that the question on home language delivered unexpected results. It was hoped that it would be possible to deduce ethnicity from the students' home language, but most students indicated their home language as being "English". This meant that the distinguishing factor of ethnic status was invisible.

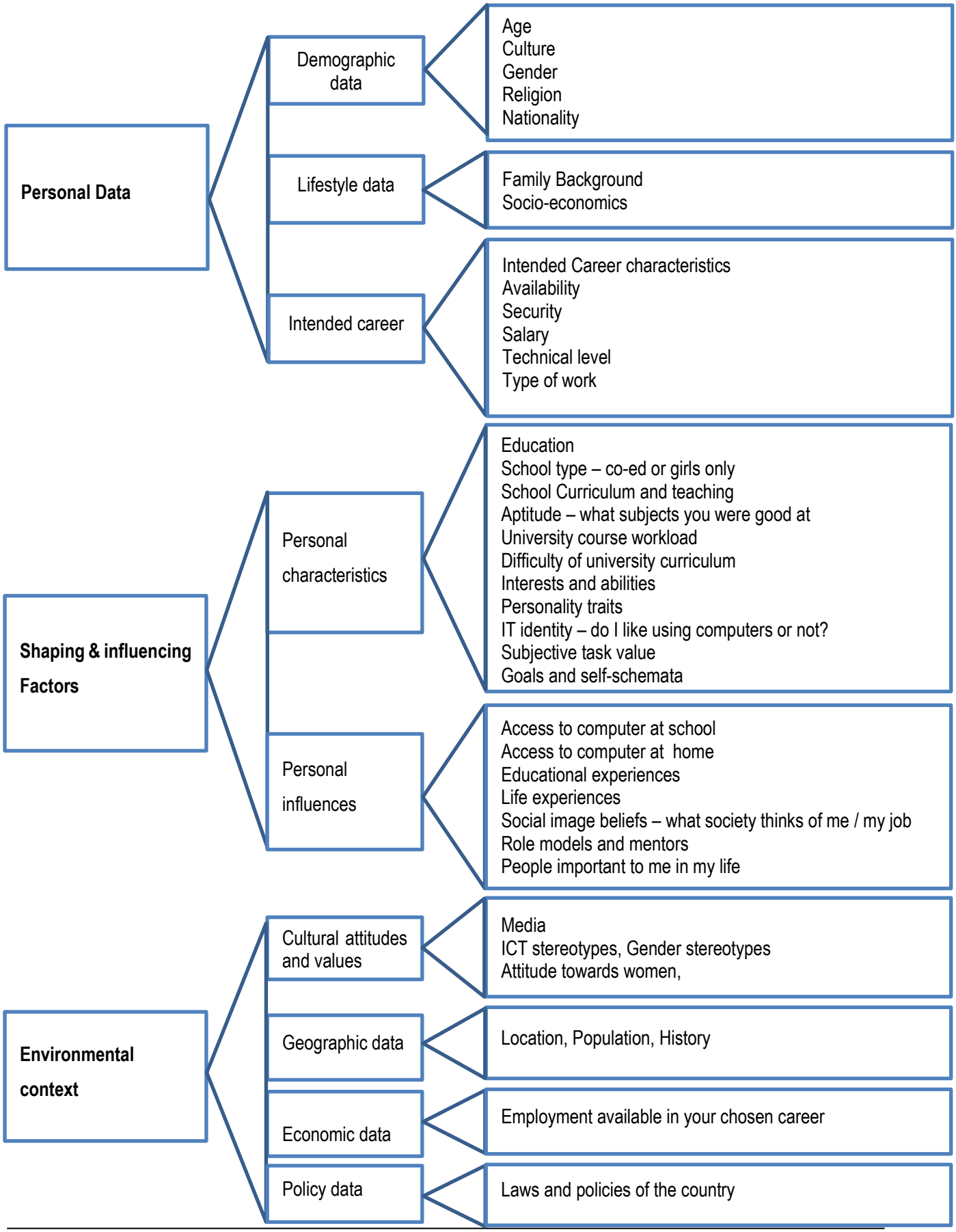
Permission was requested to add a question asking the student to explicitly indicate their race. The Department of Higher Education and training uses the following groups : "African", "Coloured", "White" and "Indian/Asian".

The question was:

Q2.2 Which race / ethnicity best describes you? (African/ Asian / Coloured / Indian / White / Other)

Approval was subsequently granted and the question was added to the second web survey.

APPENDIX D: INTERVIEW DISCUSSION FRAMEWORK



APPENDIX E: QUESTIONNAIRE FOR INFORMATICS STUDENTS

Factors influencing IT Study Choice - INF112 2018

Please enter the degree you are registered for, *e.g. BCom Accounting Sciences*	Male	
	Female	

For departmental research purposes, we would like to know how you chose to study this degree. Think of anything that influenced you – the media, available jobs, family, friends, your own interests etc.)

If your school had offered the subject Information Technology (IT), would you have taken it? Please explain your answer.

When you were at school, did you know about available studies or careers in Information Technology ?

How do you think more people can be attracted to jobs in IT?

APPENDIX F: UNIVERSITY OF PRETORIA DEGREES OFFERED

Faculty of Economic and Management Sciences	BAdmin International Relations
	BAdmin Public Management Public Administration
	BAdmin Public Management
	BCom
	BCom Accounting Sciences
	BCom Agribusiness Management
	BCom Business Management
	BCom Econometrics
	BCom Economics
	BCom Entrepreneurship
	BCom Extended programme
	BCom Financial Sciences
	BCom Human Resource Management
	BCom Informatics Information Systems
	BCom Investment Management
	BCom Law
	BCom Marketing Management
	BCom Recreation and Sports Management
	BCom Statistics
	BCom Supply Chain Management
Faculty of Education	BEd Early Childhood Development and Foundation Phase
	BEd Foundation Phase Teaching
	BEd Intermediate Phase Teaching
	BEd Senior Phase and Further Education and Training Teaching
Faculty of Engineering, Built Environment and Information Technology	BEng Chemical Engineering
	BEng Chemical Engineering ENGAGE
	BEng Civil Engineering
	BEng Civil Engineering ENGAGE
	BEng Computer Engineering
	BEng Computer Engineering ENGAGE
	BEng Electrical Engineering
	BEng Electrical Engineering ENGAGE
	BEng Electronic Engineering
	BEng Electronic Engineering ENGAGE
	BEng Industrial Engineering
	BEng Industrial Engineering ENGAGE

	BEng Mechanical Engineering
	BEng Mechanical Engineering ENGAGE
	BEng Metallurgical Engineering
	BEng Metallurgical Engineering ENGAGE
	BEng Mining Engineering
	BEng Mining Engineering ENGAGE
	BIS Multimedia
	BIS Publishing
	BIT Information Technology
	BSc Architecture
	BSc Computer Science
	BSc Construction Management
	BSc Information and Knowledge Systems
	BSc Interior Architecture
	BSc Landscape Architecture
	BSc Quantity Surveying
	BSc Real Estate
	BTRP
Faculty of Health Sciences	BChD
	BCMP
	BCur Nursing Science (Education and Administration)
	BDietetics
	BNurs
	BOccTher
	BOH
	BPhysio
	BRad Diagnostics
	BSportSci
	MBChB
Faculty of Humanities	BA Audiology
	BA Extended programme
	BA Fine Arts
	BA Humanities
	BA Information Design
	BA Languages
	BA Law
	BA Music
	BA Speech-Language Pathology
	BA Sport and Leisure Studies Sport and Leisure in Society

	BA Sport and Leisure Studies Sport and Recreation Management
	BA Sport and Leisure Studies Sports Coaching Science
	BA Sport and Leisure Studies Sports Psychology
	BA Visual Studies
	BDram
	BMus
	BPolSci International Studies
	BPolSci Political Studies
	BSocSci Heritage and Cultural Tourism
	BSocSci Industrial Sociology and Labour Studies
	BSocSci Philosophy, Politics and Economics
	BSW
Faculty of Law	LLB
Faculty of Natural and Agricultural Sciences	BConSci Clothing Retail Management
	BConSci Food Retail Management
	BConSci Hospitality Management
	BSc Actuarial and Financial Mathematics
	BSc Applied Mathematics
	BSc Biochemistry
	BSc Biological Sciences
	BSc Biotechnology
	BSc Chemistry
	BSc Culinary Science
	BSc Ecology
	BSc Engineering and Environmental Geology
	BSc Entomology
	BSc Environmental Sciences
	BSc Extended programme - Biological and Agricultural Sciences
	BSc Extended programme - Mathematical Sciences
	BSc Extended programme - Physical Sciences
	BSc Food Science
	BSc Genetics
	BSc Geography
	BSc Geoinformatics
	BSc Geology
	BSc Human Genetics
	BSc Human Physiology
	BSc Human Physiology, Genetics and Psychology
	BSc Mathematical Statistics
	BSc Mathematics

	BSc Medical Sciences
	BSc Meteorology
	BSc Microbiology
	BSc Nutrition
	BSc Physics
	BSc Plant Science
	BSc Zoology
	BScAgric Agricultural Economics and Agribusiness Management
	BScAgric Animal and Pasture Science
	BScAgric Animal Science
	BScAgric Applied Plant and Soil Sciences
	BScAgric Plant Pathology
Faculty of Theology	BDiv
	BTh
Faculty of Veterinary Science	BVSc

APPENDIX G: SYSTEMATIC LITERATURE REVIEW - CHRONOLOGICAL SELECTION OF PAPERS FOR DATA EXTRACTION.

Literature is listed according to abstract number, authors, title, year of publication, source, whether they are included or excluded, motivation and themes addressed.

#	Authors	Title	Year	Source	I / E	Motivation to exclude	Themes
1	(Nix & Perez-Felkner, 2019)	Difficulty orientations, gender, and race/ethnicity: An intersectional analysis of pathways to STEM degrees	2019	Social Sciences	I	-	Probability to declare a mathematics-intensive major : role of gender and race/ethnicity
2	(Ioannis & Maria, 2019)	Gender and Student Course Preferences and Course Performance in Computer Science Departments: A Case Study	2019	Education and Information Technologies	I		Males prefer CS courses related to hardware and software engineering, females select courses related to theoretical CS, humanities and social sciences
3	(Papavlasopoulou et al., 2019)	Coding activities for children: Coupling eye-tracking with qualitative data to investigate gender differences	2019	Computers in Human Behavior	I	-	Female students do not lack in coding competences compared to boys, but they have a different approach and different perspectives during coding activities.
4	(Collain, 2018)	You don't have to be a white male that was learning how to program since he was five.	2019	SIGCSE	I	-	All the participants had more diverse pathways into computing
5	(Cheryan et al., 2019)	Double isolation: Identity expression threat predicts greater gender disparities in computer science	2019	Self and Identity	I	-	Women experience identity expression threat
6	(Cheng, 2019)	Exploring factors influencing the acceptance of visual programming	2019	Computers in Human Behavior	I	-	Use TAM to investigate computer self-efficacy. Gender differences are found in the impact of social

		environment among boys and girls in primary schools					influence and external encouragement on students' perceptions towards programming.
7	(Hollman et al., 2019)	Information technology pathways in education: Interventions with middle school students,	2019	Computers & Education	I	-	Both scholars and teachers lack knowledge regarding IT, including what the acronym meant, technical skills needed and career expectations
8	(Lobo De Aguiar Gomes et al., 2019)	Encouraging Women to Pursue a Computer Science Career in the Context of a Third World Country	2018	2018 IEEE Frontiers in Education Conference	E	Intervention - Actions aimed to encourage women to pursue a Computer Science career in a city of a third world country (Manaus, Brazil)	
9	(Alshahrani et al., 2018)	Using social cognitive career theory to understand why students choose to study computer science	2018	ICER 2018 - ACM Conference on International Computing Education Research	I		School education has limited influence while exposure to problem solving, programming, online self-learning and internships are positive influences
10	(Mohammed Jawad et al., 2018)	The Theory of Planned Behavior and High School Students Interest in Computer Science	2018	IEEE International Conference on Electro Information Technology	I		Male students had higher interest in a CS degree. Females' decisions about their majors are more affected by role models' and parents' advice than their male counterparts. Both groups were more interested in CS when they enjoy programming and find a benefit in the degree.
11	(Stanko & Zhirosh, 2017)	Young women who choose IT: What role do their families play?	2018	Proceedings - 2017 7th World Engineering Education Forum	I		Conditions that encourage girls to consider a technical career path: family members who communicate enjoyment for their work, strong encouragement for a career in technology, and opportunities to learn about these careers. In general : Parents expected their children to develop solid maths knowledge and skills.
12	(Wu et al., 2018)	Expanding the pool of undergraduate computing students: Increasing enrolments by strategically recruiting women	2018	ASEE Annual Conference and Exposition, Conference Proceedings	E	Recruiting strategies and outcomes	
13	(Kong et al., 2018)	A study of primary school students' interest, collaboration attitude, and	2018	Computers & Education	I	-	Boys showed more interest in programming than girls did. Students in higher grade levels than others

		programming empowerment in computational thinking education.					viewed programming as less meaningful and had lower programming self-efficacy.
14	(Kallia & Sentance, 2018)	Are Boys More Confident Than Girls?: The Role of Calibration and Students' Self-efficacy in Programming Tasks and Computer Science	2018	Proceedings of the 13th Workshop in Primary and Secondary Computing Education -WiPSCE '18	I	-	Boys feel significantly more efficacious in computer science than girls
15	(Clarke et al., 2018)	Improving Diversity in Computing Research: An Overview of CRA-W Activities	2018	Proceedings of the 1st International Workshop on Gender Equality in Software Engineering - GE '18	I	-	This paper describes CRA-Ws major programs and highlights some of their impacts as demonstrated through evaluation.
16	(O'Keefe et al., 2018)	Implicit theories of interest: Finding your passion or developing it?	2018	Psychological Science	E	Discusses general approaches to career guidance, not specific to IT. People are told to find their passion, but that may lead them to put all their eggs in one basket but then to drop that basket when it becomes too difficult to carry.	
17	(Tari & Annabi, 2018)	Someone on my level: How women of color describe the role of teaching assistants in creating inclusive technology courses	2018	Americas Conference on Information Systems 2018: Digital Disruption, AMCIS 2018	I	-	Explore the role undergraduate TAs play in creating inclusive environments for women of colour in technology-related classes.
18	(Bernstein, 2018)	Cracking the Code - Sexism in Silicon Valley — and how to beat it	2018	Princeton Alumni Weekly	I	-	Stereotypes. Tech not a meritocracy but male hegemony.
19	(Patall et al., 2018)	Gender disparities in students' motivational experiences in high school science classrooms	2018	Science Education	E	Examines STEM subjects but not computer studies - Women are underrepresented in physical and engineering science fields, but well represented in biological and biomedical fields. Quality of support in class for girls is not well aligned with girls' interest, values, and preferences.	
20	(Law, 2018)	Gender and mathematics: Pathways to mathematically intensive fields of study in Australia	2018	Advances in Life Course Research	I	-	The expectation of a mathematically oriented career has the greatest potential to bridge the gender gap.
21	Yu, Weng, Chang	Students' learning motivation to math and science: Using the meta-	2018	Contemporary Educational Research Quarterly	E	Unable to source - Essentialist gender IT performance. Meta-analysis results showed that male students outperform female students.	

		analysis to find the gender difference in Taiwan					
22	(Potvin et al., 2018)	Gendered interests in electrical, computer, and biomedical engineering: Intersections with career outcome expectations	2018	IEEE Transactions on Education	I	-	Female-identified students report stronger associations between 'helping others' and interest in bioengineering/biomedical engineering and report less interest in electrical and computer engineering overall.
23	(Shi, 2018)Shi	The puzzle of missing female engineers: Academic preparation, ability beliefs, and preferences	2018	Economics of Education Review	E	Focus on STEM. No IT differentiation Disparities in female engineering degree uptake are the result of differential entry during primary and high school.	
24	(Michell et al., 2018)	Towards a socio-ecological framework to address gender inequity in computer science,	2018	Computers & Education,	I	-	Bronfenbrenner's socio-ecological systems theory - student interest and engagement in computer science impacted by various spheres of influence
25	(Jung et al., 2017)	Closing the Gender Gap in the Technology Major	2017	Information Systems Education Journal	I		The influences that impact the choice of a woman's selection in a degree of study related to technology.
26	Schafer, V. and Thierry, B. G.	Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing	2017	Book -Springer Publishing Company, Incorporated	E	Unable to source	
27	Abbate, J.	Geek Girl Rising: Inside the Sisterhood Shaking Up Tech	2017	Book -The MIT Press	E	Unable to source	
28	(Cheryan et al., 2016)	Why are some STEM fields more gender balanced than others?	2017	Psychological Bulletin	I	-	Masculine computing cultures hostile to girls
29	Camp et al	Generation CS: The mixed news on diversity and the enrolment surge	2017	ACM Inroads	E	Study on managing enrolments - Growth of computer science in the US. CRA Enrolment Survey - actions taken by units to manage the CS enrolment surge and their impact on diversity.	
30	Outlay, Platt and Conroy	Getting IT Together: A Longitudinal Look at Linking Girls' Interest in IT Careers to Lessons Taught in Middle School Camps	2017	ACM Trans. Comput. Educ.	E	Interventions - Interventions must explicitly tie technology activities to careers	

31	Nishijima, Ivanauskas, Sarti	Evolution and determinants of digital divide in Brazil (2005-2013),	2017	Telecommunications Policy,	E	Digital divide due to lack of ICT access – The digital divide in developing countries (Brazil) is decreasing but digital illiteracy, due to lack of education, is one of the determinants of the digital divide in the country.	
32	(Hodges & Corley, 2017)	Reboot: Revisiting Factors Influencing Female Selection of the CIS Major	2017	Information Systems Education Journal	I	-	Experiential beliefs, overall image, job accessibility, and educational cost (workload) influence academic path selection.
33	(Riegle-Crumb & Morton, 2017)	Gendered expectations: Examining how peers shape female students' intent to pursue STEM fields.	2017	Frontiers in Psychology	I	-	Peers are an important source of messages regarding whether or not girls should pursue CS.
34	(Perez-Felkner et al., 2017)	Gendered pathways: How mathematics ability beliefs shape secondary and postsecondary course and degree field choices	2017	Frontiers in Psychology	I	-	Mathematical efficacy beliefs span high school years. Even at the same levels of observed ability, girls' mathematics ability beliefs are markedly lower than those of boys.
35	(Lehman et al., 2017)	Women planning to major in computer science: Who are they and what makes them unique?	2017	Computer Science Education	I	-	Findings reveal a unique profile of women who pursue the CS major and notes many significant differences between men and women in CS and between women in CS and those in other STEM fields
36	Atak et al	Development of a game-design workshop to promote young girls' interest towards computing through identity exploration,	2017	Computers & Education,	E	Intervention - The importance of providing positive identity exploration opportunities in shaping female students' attitudes towards CS.	
37	(Witherspoon et al., 2016)	Gender, Interest, and Prior Experience Shape Opportunities to Learn Programming in Robotics Competitions	2016	International Journal of STEM Education	I	-	Robotics competition experiences motivate students to learn more programming, yet gender persist in these learning environments and widen as students grow older and enter more advanced competitions.
38	(Trauth et al., 2016)	The Influence of Gender-Ethnic Intersectionality on Gender Stereotypes About IT Skills and Knowledge	2016	SIGMIS Database	I	-	Gender stereotypes about the skills and knowledge involved in the IT profession exist, but they are not uniform across all members of a gender group.

39	(Cerf & Johnson, 2016)	Enrolments Explode! But diversity students are leaving...	2016	Communications of the ACM	E	Opinion piece - Insights on the lack of diversity in computer science (CS) education.	
40	(Mitra, 2016)	A Byte Is All We Need.	2016	Communications of the ACM	I	-	Parents need to see that coding is not difficult or boring.
41	Deechuay et al	Relationship between gender identity, perceived social support for using computers, and computer self-efficacy and value beliefs of undergraduate students	2016	Education and Information Technologies	E	Impact factor <0.5 - Gender role socialization and expectancy-value theories are used to interpret group differences in computer self-efficacy and value beliefs	
42	(Dubow & James-Hawkins, 2016)	What Influences Female Interest and Persistence in Computing?: Preliminary Findings from a Multiyear Study	2016	Computing in Science & Engineering	I	-	Less confident females who study high school IT could benefit from being recognized.
43	(Sax et al., 2015).	"But I'm Not Good at Math": The Changing Salience of Mathematical Self-Concept in Shaping Women's and Men's STEM Aspirations	2015	Research in Higher Education	I	STEM fields	Women's lower math confidence has become a less powerful explanation for their under-representation in STEM fields.
44	Varma R., Kapur D.	Decoding femininity in computer science in India	2015	Communications of the ACM	E	Factors influencing IT degree completion (not enrolment)	
45	(A. Lee, 2015)	Determining the effects of computer science education at the secondary level on STEM major choices in postsecondary institutions in the United States.	2015	Computers & Education	I	-	Promoting the quality of computer science education is just as important in motivating students to pursue STEM education and career choices at the secondary level as are math and science education
46	(Wang et al., 2015)	Gender differences in factors influencing pursuit of computer science and related fields	2015	Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE	I	-	Encouragement and exposure influence this important choice for women. Influence of family is critical.

47	(Fuller et al., 2015)	Understanding career choice of African American men majoring in information technology	2015	Proceedings of the 2015 ACM SIGMIS Conference on Computers and People Research	I	-	African American men - Family strongly encouraged the men to attend college, but it did not steer the men to major in IT. Role models and strong work ethic necessary.
48	(Cain & Trauth, 2015)	Theorizing the underrepresentation of Black males in information technology (IT)	2015	2015 Americas Conference on Information Systems, AMCIS 2015	I	-	How do individual, societal and institutional characteristics, influence IT degree pursuit and attainment by Black males.
49	(Lord et al., 2015)	Multi-Institution Study of Student Demographics and Outcomes in Electrical and Computer Engineering in the USA	2015	IEEE Transactions on Education	I	-	Trajectories of student enrolment differ by race/ethnicity in Electrical Engineering (EE) and Computer Engineering (CpE)
50	Pretorius, et al	Continuing the discourse of women in information technology	2015	Gender, Technology and Development	E	IT workforce - South African domestic and IT work environments.	
51	(Drabowicz, 2014)	Gender and digital usage inequality among adolescents: A comparative study of 39 countries.	2014	Computers & Education	I	-	Boys report using computers and the Internet for educational purposes more often than girls
52	Beyer, Sylvia	Why are women underrepresented in Computer Science? Gender differences in stereotypes, self-efficacy, values, and interests and predictors of future CS course-taking and grades.	2014	Computer Science Education	I		Gender differences in computer self-efficacy, stereotypes, interests, values, interpersonal orientation, and personality exist. Identifies personality - CS fit
53	Denner et al	Community College Men and Women: A Test of Three Widely Held Beliefs About Who Pursues Computer Science	2014	Community College Review	E	How to increase the number of CIS majors, particularly females, at community colleges	
54	DuBow, Wendy	Attracting and Retaining Women in Computing.	2014	Computer	E	Interventions	
55	(Google, 2014)	Women Who Choose Computer Science - What Really Matters - The Critical Role of Encouragement and Exposure	2014	Online	I	Quality data	The controllable factors of encouragement and exposure are the largest influencers.

56	(Yang et al., 2013)	Computers and the academic performance of elementary school-aged girls in China's poor communities.	2013	Computers & Education	I	-	Among disadvantaged students in China's rural areas and migrant communities, computer-based learning benefit girls and boys equally.
57	(Cheryan, Drury, et al., 2013)	Enduring Influence of Stereotypical Computer Science Role Models on Women's Academic Aspirations	2013	Psychology of Women Quarterly	I	-	Exposure to the stereotypical role model had both an immediate and an enduring negative effect on women's interest in computer science.
58	(Cheryan, Plaut, et al., 2013)	The stereotypical computer scientist: Gendered media representations as a barrier to inclusion for women.	2013	Sex Roles: A Journal of Research	I	-	Stereotypes- computer scientists were perceived as having traits that are incompatible with the female gender role, such as lacking interpersonal skills and being singularly focused on computers.
59	(Ashcraft et al., 2012)	Girls in IT: The Facts	2013	SIGCSE '13	I	-	USA Report on Women in Tech
60	(Maneschijn et al., 2013)	A critical review of ICT skills for higher education learners.	2013	In 2013 International Conference on Adaptive Science and Technology.	E	IT Skills / Job descriptions	
61	(Hohlfeld et al., 2013)	Are gender differences in perceived and demonstrated technology literacy significant? It depends on the model.	2013	Educational Technology Research & Development	I	-	Found that gender differences are statistically insignificant in computer skills
62	Gokhale A.A., Brauchle P.E., Machina K.F.	Scale to measure attitudes toward information technology	2013	International Journal of Information and Communication Technology Education	E	Unable to source Pursuit of information technology (IT) majors depends on students' attitudes toward these majors. This study developed an Attitude toward IT Scale with a gender subtext to measure college students' attitudes toward IT	
63	(Bock, 2013)	Women and minorities in computer science majors: Results on barriers from interviews and a survey.	2013	Issues in Information Systems	I	-	Barrier for women is that computer science is better suited to men. For minorities (black and Hispanic), lack of computer experience and the perception that computer science is for geeks and nerds are the two significant barriers.

64	(Banerjee & Maria, 2013)	A Study of Students' Perception of Computer Education: Lack of Interest in STEM Fields for Female Students.	2013	International Journal of Technology, Knowledge & Society	I		Female students exhibit much less interest in computer courses or careers than their male counterparts.
65	(Doubé & Lang, 2012)	Gender and Stereotypes in Motivation to Study Computer Programming for Careers in Multimedia	2012	Computer Science Education	I	-	The stereotype associated with a creative multimedia career could attract female participation in computer programming whereas the stereotype associated with computer science could be a deterrent.
66	(Sáinz & Eccles, 2012)	Self-Concept of Computer and Math Ability: Gender Implications across Time and within ICT Studies	2012	Journal of Vocational Behavior	I	-	Self-concept of computer ability is higher in boys at both times; furthermore it decreases in girls and increases in boys over time.
67	Mahatanankoon P., Watanapa B., Sathapornvajana S.	Gender gap in information technology (It) majors: A preliminary study on cross-cultural perspective	2012	Proceedings - Pacific Asia Conference on Information Systems, PACIS 2012	I	-	Thai female students have higher external locus of control and parental influence, and lower perception of career opportunities
68	(Lang, 2012)	Sequential attrition of secondary school student interest in IT courses and careers.	2012	Information Technology & People	I	-	A lack of student knowledge of what an IT career involves. IT has an image of lower status than most other professional careers. Parents remain the primary influencers to student career and course choices.
69	(Frieze et al., 2012)	Diversity or Difference? New Research Supports the Case for a Cultural Perspective on Women in Computing	2012	Journal of Science Education and Technology	I	-	Women, alongside their male peers, can fit successfully into a CS environment without accommodating presumed gender differences or any compromises to academic integrity.
70	(Pau et al., 2011)	"It's Boring": Female Students' Experience of Studying ICT and Computing	2011	School Science Review, v92 n341 p89-94 Jun 2011	I	-	Male and female students have very different experiences of computing at school
71	(Rosson et al., 2011)	Orientation of Undergraduates toward Careers in the Computer and Information Sciences: Gender, Self-Efficacy and Social Support	2011	ACM Transactions on Computing Education	I	-	Strong social support and high self-efficacy are associated with strong orientation toward CIS careers.

72	(Guthrie et al., 2011).	How did mathematics and accounting get so many women majors? What can IT disciplines learn?	2011	Proceedings of the 2011 ACM Special Interest Group for Information Technology Education Conference	I	-	IT is not building alliances and options that might be interesting to women, or defining IT and associated career paths in a way that pre-college students can understand.
73	(Crutchfield et al., 2011)	Berkeley Foundation for Opportunities in Information Technology: A Decade of Broadening Participation	2011	ACM Transactions on Computing Education	I	-	Funding important in preparing females from underrepresented racial and ethnic minorities in the USA, to the fields of computer science and engineering.
74	(Saleem et al., 2011)	Antecedents of computer self-efficacy: A study of the role of personality traits and gender.	2011	Computers in Human Behavior	I	-	Big-5 factors of personality. The traits of neuroticism, extraversion, and agreeableness are related to computer self-efficacy for women but not for men.
75	(Castaño & Webster, 2011)	Understanding Women's Presence in ICT: The Life Course Perspective	2011	International Journal of Gender, Science and Technology	E	Discussion piece. Advocates a 'life course' approach to the understanding of the paths women take throughout their ICT studies and careers.	
76	Trauth E.	What can we learn from gender research? Seven lessons for business research methods	2011	Electronic Journal of Business Research Methods	E	Focuses on research methods and not factors that influence IT enrolment - Issues with gender research in the information technology (IT) field over the past decade	
77	(Croasdell et al., 2011)	Why don't more women major in information systems?	2011	Information Technology and People	I	-	A "genuine interest in IS" and the "influence of family" most account for a woman's decision to major in IS
78	Roach D., McGaughey R.E., Downey J.P.	Gender within the IT major - A retrospective study of factors that lead students to select an IT major	2011	International Journal of Business Information Systems	E	Unable to source	Four major influences on students' choice of IT major : social influences, interesting work, extrinsic rewards, and cognitive beliefs (computer self-efficacy and anxiety)
79	(Ma, 2011)	College major choice, occupational structure and demographic patterning by gender, race and nativity.	2011	The Social Science Journal	E	Not specific to IT - Seemingly individual choice of college major has deep structural roots at the societal level.	

80	(Sáinz & López-Sáez, 2010)	Gender differences in computer attitudes and the choice of technology-related occupations in a sample of secondary students in Spain.	2010	Computers & Education	I	-	Adolescents from lower social class use computers less frequently than adolescents from upper and intermediate social class - socioeconomic background was found to be a stronger predictor of whether or not a student had access to a computer at home, than gender.
81	Pretorius, H., de Villiers, C.	A South African Perspective of the International Discourse About Women in Information Technology	2010	SAICSIT '10	E	IT Workforce - Do South African women experience similar levels of career problems in the IT industry compared to international trends?	
82	(Lang, 2010)	Happenstance and Compromise: A Gendered Analysis of Students' Computing Degree Course Selection	2010	Computer Science Education	I		Students of both genders appear to be socialised away from this discipline, which is perceived as a support or insurance skill, not a career in itself, in all but the most technical-oriented (usually male) student.
83	(Laosethakul & Leingpibul, 2010)	Why Females Do Not Choose Computing? A Lesson Learned from China	2010	Multicultural Education & Technology Journal	I	-	American females' gender perception toward computing is influenced by computer anxiety and CSE. Chinese females perceive equal opportunity between men and women in IT.
84	(Roli Varma, 2010)	Why so few women enrol in computing? Gender and ethnic differences in students' perception	2010	Computer Science Education	I	-	Bias in early socialization and anxiety toward technology as two main factors responsible for the under-representation of women in CS/CE education. Differences between students from different ethnic groups.
85	(Leiviskä & Siponen, 2010)	Attitudes of Sixth Form Female Students Toward the IT Field	2010	SIGCAS Comput. Soc.	I	-	Girls don't perceive field to be human-related. Deterred by perceived level of mathematics and physics skills. Necessary to clarify different IT fields / jobs.
86	(Lasen, 2010)	Education and career pathways in Information Communication Technology: What are schoolgirls saying?	2010	Computers & Education	I	-	A lack of understanding of IT, with many associating ICT subjects with programming and other highly technical skills. Positive response to interviewers' descriptions of IT; its broader appeal is shown in growing enrolments.

87	(Ceci et al., 2009)	Women's Underrepresentation in Science: Sociocultural and Biological Considerations	2009	Psychological Bulletin, APA	I		Women's participation in math-intensive fields depend on their own preferences. Performance on gatekeeper tests also play a role but results stem from sociocultural and not biological causes.
88	Dickinson S., Kulturel S.	Review of gender differences in learning styles: Suggestions for Information Technology education	2009	15th Americas Conference on Information Systems 2009, AMCIS 2009	E	Learning theory for education - Gender differences in learning styles.	
89	(Meszaros et al., 2009)	Understanding the role of parental support for IT career decision making using the theory of self-authorship.	2009	International Journal of Consumer Studies	I	-	Parents are integral to the career choice process, even throughout the college years.
90	(von Hellens et al., 2017)	Perceptions of ICT Careers in German Schools: An Exploratory Study	2009	Journal of Information Technology Education	I		Senior secondary students have not decided what they want to do when they finish school, an opportunity for recruiting them to IT.
91	(Roli Varma, 2009c)	Why I chose computer science? Women in India	2009	15th Americas Conference on Information Systems 2009, AMCIS 2009	I	-	Women in India are attracted to CS education - they perceive CS as a woman-friendly field.
92	(Miles, 2009)	The Challenges and Factors That Determine Female Career Choices in Information Technology Professions: An Exploratory Investigation	2009	Thesis	I		Factors that determine career choices for women in the IT arena: family, role models, job satisfaction.
93	(Roli Varma, 2009b)	Gender differences in factors influencing students towards computing.	2009	Computer Science Education	I	-	This study shows a gendered digital divide. Female students had late exposure to computers both at home and in schools.
94	(Baloğlu et al., 2009)	The Predictors of Success in Computer Courses Among High School Students	2009	Psychological Reports	I		Computer Anxiety has a more detrimental effect on students with lower academic ability than on those with higher academic ability
95	(Roli Varma, 2009a)	Exposure, training, and environment: Women's participation in computing	2009	Journal of Women and Minorities in Science and Engineering	I	-	Intra-cultural aspects: the image of computing is of a women-friendly field in India, whereas in the United States, it is of a masculine field.

		education in the United states and India					
96	(Georgiadou et al., 2009)	Women's ICT career choices: Four cross-cultural case studies	2009	Multicultural Education and Technology Journal	I	-	UK, Greece, Malaysia and China - similarities & differences identified w.r.t. the under-representation of women in IT, and the effect of national culture.
97	(Heinze & Hu, 2009)	Why college undergraduates choose IT: A multi-theoretical perspective	2009	European Journal of Information Systems	I	-	College undergraduates with positive attitudes towards IT careers and high perceived behavioural control (PBC) regarding IT majors, had a greater intention of pursuing IT majors.
98	Eidelman, L. Hazzan, O.	Sectoral and Gender-Wise Analysis of the Choice of Computer Science Studies in Israeli High Schools	2008	Journal of Computers in Mathematics and Science Teaching	I	Study pertains number of students and not their choices	Differences found in ratios of female high school students studying advanced Computer Science.
99	Koch, S. C., Muller, S.	Women and Computers: Effects of Stereotype Threat on Attribution of Failure	2008	Computers & Education,	E	Study does not pertain to choice of IT major - Stereotype threat effect on women's attribution of failure: in the negative threat condition, women attributed the failure more internally and men more externally.	
100	Lent, R. W., Lopez, A.	Social Cognitive Career Theory and the Prediction of Interests and Choice Goals in the Computing Disciplines	2008	Journal of Vocational Behavior	E	Study investigates persistence of students who have already chosen a CS major - Interests across gender, educational level, and type of university among students in a variety of computing disciplines.	
101	Craig, A.; Lang, C.	Twenty Years of Girls into Computing Days: Has It Been Worth the Effort?	2008	Journal of Information Technology Education, v7 p339-353 2008	E	Intervention to balance gendered IT environment - We cannot afford to dismiss these day-long programs to encourage girls to consider computing as a career.	
102	(L. Morris, 2004)	Perceptions of a chilly climate: Differences in traditional and non-traditional majors for women	2008	Research in Higher Education	I	-	Students in traditionally female-dominated majors perceived the climate chillier than students in traditionally male-dominated majors.
103	(Meelissen & Drent, 2008)	Gender differences in computer attitudes: Does the school matter?	2008	Computers in Human Behavior	I	-	Most of the variance in computer is explained by none-school related student factors for both genders. A teacher-centred pedagogical approach and the computer experience of female teachers have a small positive effect.

104	(Papastergiou, 2008)	Are Computer Science and Information Technology Still Masculine Fields? High School Students' Perceptions and Career Choices	2008	Computers & Education	I	-	Misconceptions of CS were detected in students of both genders. Girls view CS as a self-referencing, machine- and programming-oriented discipline to a greater extent than boys do, and hold less positive views of the IT profession.
105	(R. Varma & Hahn, 2008)	Gender and the pipeline metaphor in computing	2008	European Journal of Engineering Education	I	-	Differential access to computers, culture: male organisational culture: high workload.
106	(Anderson et al., 2008)	Because it's boring, irrelevant and I don't like computers: Why high school girls avoid professionally-oriented ICT subjects,	2008	Computers & Education,	I	-	Senior high school girls tend to perceive advanced computing subjects as boring and they express a strong aversion to computers.
107	(Tien & Fu, 2008)	The correlates of the digital divide and their impact on college student learning,	2008	Computers & Education,	I	-	Influence of demographic and socioeconomic family background in first-year college students' computer confidence and use.
108	(Marsh, 2007)	Socio-political Factors and Female Students' Choice of Information Technology Careers: A South African Perspective (Chapter 7)	2007	Book : Reconfiguring the Firewall : recruiting women to information technology across cultures and continents	I	-	Females enrol for IT-related majors : promise of lucrative career
109	Grant, Donna M.	Young Women's Misinformation Concerning IT Careers: Exchanging One Negative Image for Another.	2007	Informing Science	E	Journal impact factor < 0.5	
110	Quesenberry and Trauth	What Do Women Want?: An Investigation of Career Anchors Among Women in the IT Workforce	2007	SIGMIS CPR '07	E	IT Workforce	
111	(Lang, 2007)	Twenty-First Century Australian Women and IT: Exercising the Power of Choice	2007	Computer Science Education	I	-	Many young women, when faced with an array of career choices, appear to be exercising this power of choice to exclude IT from their list of possible futures.
112	(Bovée et al., 2007)	Computer attitudes of primary and secondary students in South Africa	2007	Computers in Human Behavior	I	-	Computer attitudes of primary and secondary school students in South Africa. Access and

							experience, which was significantly lower in the township schools, was also related to computer attitude.
113	J. McGrath Cohoon Zhen Wu	International and US citizen women: A comparison of motivations for entering graduate computing programs.	2006	Equal Opportunities International	E	Journal impact factor < 0.5 - women's interest in and enjoyment of computing draw them to IT.	
114	Teo, Timothy	Attitudes toward computers: A study of post-secondary students in Singapore.	2006	Interactive Learning Environments	E	Unable to gain access	Differences in computer attitudes were found between students who own computers at home and those who do not. Students who own a computer at home also reported a lower level of computer anxiety compared to those who do not
115	Eileen M. Trauth and Jeria L. Quesenberry and Haiyan Huang	Cross-cultural Influences on Women in the IT Workforce	2006	SIGMIS CPR '06	E	IT Workforce	-
116	(Beyer et al., 2004)	Gender differences and intragender differences in computer science students: Are female cs majors more similar to male cs majors or female nonmajors?	2006	Journal of Women and Minorities in Science and Engineering	I	-	Intra-majors and intra-gender differences in CS students
117	(Carter, 2006)	Why Students with an Apparent Aptitude for Computer Science Don't Choose to Major in Computer Science	2006	SIGCSE Bull.	I	-	Students choose not to major in CS because they have an incorrect or no perception of what the field is. Only 8% of students had taken any formal classes in CS outside of Computer Applications.
118	(Othman & Latih, 2006)	Women in Computer Science: No Shortage Here!	2006	Communications of the ACM	I	-	Even though male students spend significantly more time playing computer games, programming, and hacking, these activities do not result in outpacing female students. There is no gender bias

							with regard to how CS/IT is perceived by young Malaysians.
119	(Rosenbloom et al., 2008)	Why are there so few women in information technology? Assessing the role of personality in career choices	2006	Journal of Economic Psychology, 1-24	I	-	The under representation of women in IT reflects their choice in response to differences in actual or perceived job characteristics.
120	Shumba R., Hapenyengwi G.	Why aren't Zimbabwean girls getting into computer science?	2005	8th IFIP World Conference on Computers in Education, WCCE 2005	E	Unable to source document	effect of gender on the choice of computer Science as a career
121	Guzman et al	What attracts women to the IT field? The first process of occupational socialization	2005	AIS - 11th Americas Conference on Information Systems	E	Occupational socialization of female students in IT majors	
122	George, J., Valacich, J., Valor, J.,	Does Information Systems Still Matter? Lessons for a Maturing Discipline	2005	Communications of the Association for Information Systems, 16 (8), 219-232	E	Suggestions for increasing US IT **workforce** after dotcom bubble bust. After dotcom bubble burst & global outsourcing to cheaper labour, a decline in enrolments in IS faced due to a decline in the demand for IS personnel in industry. Education important - gives suggestions for introductory IS courses	
123	Blum, L., Frieze, C.	The Evolving Culture of Computing.	2005	Frontiers: A Journal of Women Studies	E	Intervention to balance gendered IT environment	
124	(Blum & Frieze, 2005)	In a more balanced computer science environment, similarity is the difference and computer science is the winner	2005	Computing Research News	I	-	Fundamental misconceptions about computer science (that computer science = programming) are a root cause of gender under-representation.
125	Blickenstaff	Women and science careers: leaky pipeline or gender filter?	2005	Gender and education, 17(4), pp.369-386.	E	Discuss STEM aspects. Nothing on unique nature of IT.	
126	(M. Ahuja et al., 2004)	Exploring antecedents of gender equitable outcomes in IT higher education	2004	Proceedings of the ACM SIGMIS CPR Conference	I	-	The prospects for women may be brighter in the growing number of IT-related professions that do not require training in computer science, but rather in cognate disciplines such as information science, management information systems, instructional systems technology, and informatics.

127	(Weinberger, 2004)	Just ask! Why surveyed women did not pursue IT courses or careers.	2004	IEEE Technology and Society Magazine	I	-	Equal proportions of men and women feared that choosing IT major would lead to social ostracism.
128	Cooper and Weaver, 2003	Gender and Computers: Understanding the Digital Divide	2003	Book : Gender and Computers	E	Could not source : TOC only	
129	(A. C. K. Lee, 2003)	Undergraduate students' gender differences in IT skills and attitudes.	2003	Journal of Computer Assisted Learning	E	Success factors in studies	
130	van der Merwe and Stander, 2003	The Retention of Women in Information Technology: A South African Perspective.	2003	Managing Globally with Information Technology	E	Workforce not students (Study of women in the South African IT Industry)	
131	(Katz et al., 2006)	Gender and race in predicting achievement in computer science	2003	IEEE Technology and Society Magazine	E	Success factors on performance and persistence in undergrad CS programs - Gender and race differences between prospective computer or information science majors.	
132	(Almstrum & Last, 2006).	What is the Attraction to Computing?	2003	CACM Sept 2003	I	A four-dimensional model of attraction to computing	Girls were less confident of their abilities and possessed lower IT skill levels than boys before starting their university education. Additional factors, including money, opportunity, and job security, also attracted them to computing.
133	Beise et al	A Model for Examination of Underrepresented Groups in the IT Workforce	2002	SIGCPR '02	E	Success factors in studies - Neither gender nor age is a good predictor of success in CS or IT courses.	
134	Cantwell Wilson, Brenda	A Study of Factors Promoting Success in Computer Science Including Gender Differences.	2002	Computer Science Education	E	Success factors in studies - Factors that promote success in an introductory college computer science course: comfort level, math background. No significant gender differences.	
135	Clayton and Lynch	Ten Years of Strategies to Increase Participation of Women in Computing Programs: The Central Queensland University Experience: 1999-2001	2002	SIGCSE Bulletin	E	Interventions to increase number of females in CS majors	
136	Young, Betty J.	Gender Differences in Student Attitudes toward Computers.	2000	Journal of Research on Computing in Education	E	Unable to source. Computer attitudes of middle and high school students.	

137	Lee, D.M., Trauth, E.M. and, Farwell D.	Critical skills and knowledge requirements of IS professionals: a joint academic/industry investigation	1995	MIS quarterly, pp.313-340.	E	Not seen from the point of view of the individual making the study/career choice - IT Skills / Job descriptions

APPENDIX H: SYSTEMATIC LITERATURE REVIEW – THEME MATRIX

Themes	S1	S2	S3	S4	S5	S6	S7	S9	S10	S11	S13	S14	S15	S16	S17	S18	S20	S22	S24	S25	S28	S32	S33	S34	S35	S37	S38	S40	S42	S43	S45	S46	S47	S48	S49	S51	S52	S55	S56	S57	S58	S59	S61	S63	S64
Personal																																														
Mathematics difficulty	X																																													
Technology anxiety																																													
Subject preference		X									X							X				X																							
Computer self-Efficacy												X								X				X					X															
Gaps in programming involvement																										X																			
Coding skills vs approach			X																																								X		
Perceived usefulness						X																																							
Psychological variables																																				X									
Genuine interest in IS																																													
Microsystem - peers parents teachers																																													
Parents the primary influencers																																													
Parents must be informed																												X																	
Lack of knowledge - IT & careers							X																										X	X										X
Family/ teacher encouragement										X												X						X	X			X						X						
Peers																							X																						
School education: limited influence								X																														X	X					
Meso system- education , industry																																													
Knowledge of software																																													
Tech is a male hegemony																X																													
Females uninterested in tech careers																																													X
Mathematics important - IT career																	X																												
Females who do school IT: confident																													X																
School IT mundane, repetitive																																													
Secondary students: career-undecided																																													
Lack of potential IT job satisfaction																																													
Female workforce issues																																													
Male students = work experience																																													

Themes	S65	S66	S67	S68	S69	S70	S71	S72	S73	S74	S77	S80	S82	S83	S84	S85	S86	S87	S89	S90	S91	S92	S93	S94	S95	S96	S98	S10	S10	S10	S10	S10	S10	S11	S11	S11	S11	S11	S11	S12	S12	S12	S13
Personal																																											
Mathematics difficulty																																											
Technology anxiety															X								X	X																			
Subject preference												X	X										X						X		X						X		X			
Computer self-Efficacy		X					X											X																	X							X
Gaps in programming																																											
Coding skills vs																																											
Perceived usefulness																													X														
Psychological variables										X																											X					
Genuine interest in IS											X																																
Microsystem - peers																																											
Parents the primary			X																X			X																					
Parents must be																																											
Lack of knowledge -				X								X					X					X					X			X							X			X			
Family/ teacher											X								X			X							X													
Peers																																											
School education:																																											
Meso system- education																																											
Knowledge of software																																X											
Tech is a male																												X															
Females uninterested in																														X			X										
Mathematics important -																																											
Females who do school															X														X														
School IT mundane,																	X						X																				
Secondary students:																				X																							
Lack of potential IT job																						X																					
Female workforce																																											
Male students = work																													X														

Themes	S1	S2	S3	S4	S5	S6	S7	S9	S10	S11	S13	S14	S15	S16	S17	S18	S20	S22	S24	S25	S28	S32	S33	S34	S35	S37	S38	S40	S42	S43	S45	S46	S47	S48	S49	S51	S52	S55	S56	S57	S58	S59	S61	S63	S64
Exosystem - School, Social Env																																													
Society impacts student engagement														X					X																											
Media images - misleading																				X																									
Stereotypes misleading																											X														X			X	
Diverse pathways into computing				X																																									
Identity expression threat for WinIT					X																																								
Role models for Girls- important									X						X																										X				
Exposure to problem solving - positive								X												X																									
Misleading belief - be smart																																													
Girls disadvantaged - not gaming																																	X			X								
Diff in school computing experiences																																													
Strong social support necessary																																													
Money, opportunity, job security- attractions																																													
Macrosystem - Country, technologies																																													
Improve quality of CS education																															X														
Funding important for URMs																																													
Computing skills in wide demand, all welcome													X								X																								
Diversity in hiring is improving																X																													
Intersectional themes																																													
Enrolment and persistence patterns																																			X										
Unique profile of CS women																									X																				
Caution advised in gender differences																																													
Focus on culture and environment																																													
Challenge is cultural																																													
Females from collective societies																																													
Gender => diversity																																													
Disaggregate by race/ethnicity, gender																																			X										
Interdisciplinary work													X																																

Themes	S65	S66	S67	S68	S69	S70	S71	S72	S73	S74	S77	S80	S82	S83	S84	S85	S86	S87	S89	S90	S91	S92	S93	S94	S95	S96	S98	S102	S103	S104	S105	S106	S107	S108	S111	S112	S116	S117	S118	S119	S124	S126	S127	S132
Exosystem - School, Social Env																																												
Society impacts student engagement																										X																			
Media images - misleading																																											
Stereotypes misleading	X											X																															
Diverse pathways into computing																																											
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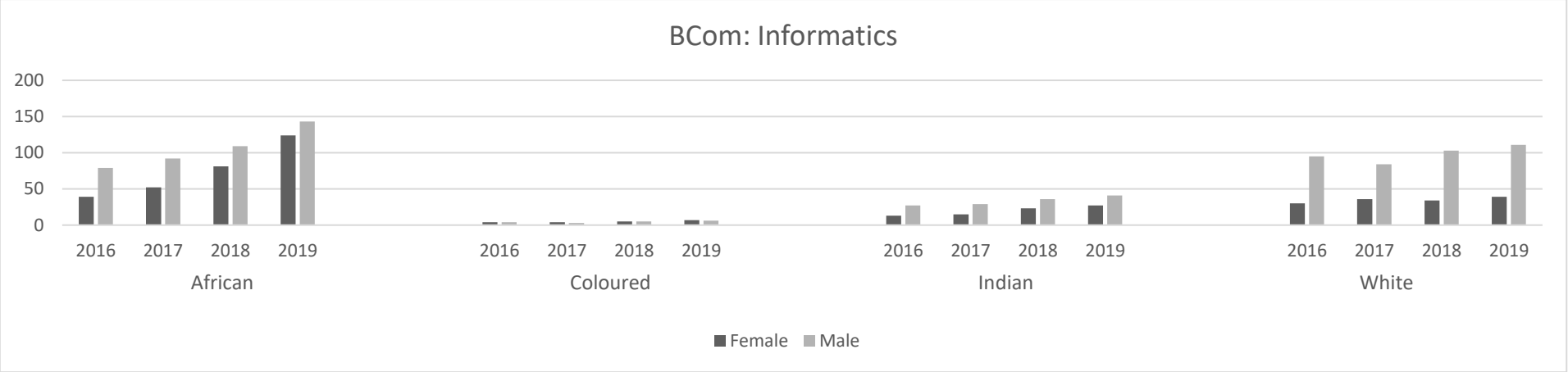
Money, opportunity, job security																																											X
Macrosystem - Country, technologies																																											
Improve quality of CS education																																											
Funding important for URMs									X																																		
Computing skills in demand, all welcome																X																											
Diversity in hiring is improving																																											
Intersectional themes																																											
Enrolment and persistence patterns																																											
Unique profile of CS women																																											
Caution in gender differences research				X																																							
Focus on culture and environment					X																																						
Challenge is cultural																																										X	
Females from collective societies		X																													X		X									
Gender => diversity																																			X								
Disaggregate by race/ethnicity, gender																																X											
Interdisciplinary work								X																																			

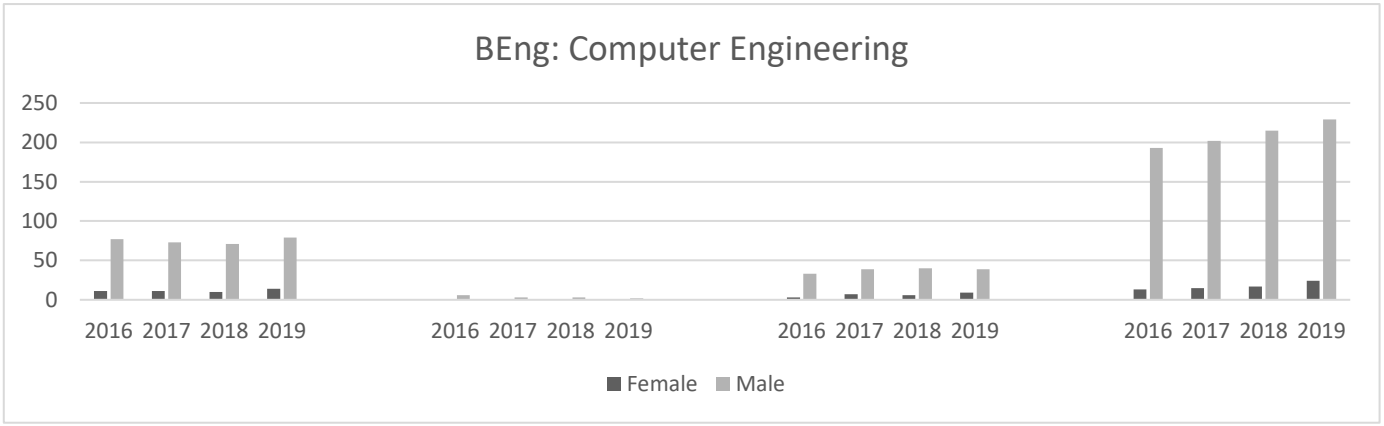
APPENDIX I: UNIVERSITY OF PRETORIA STUDENT REGISTRATION NUMBERS FOR IT DEGREES: 2016-2019

The student numbers are disaggregated according to gender and the four main ethnic groups in South Africa as per Statistics SA. The numbers are presented in the following order: students belonging to the Black, Coloured, Indian/Asian and White ethnic groups.

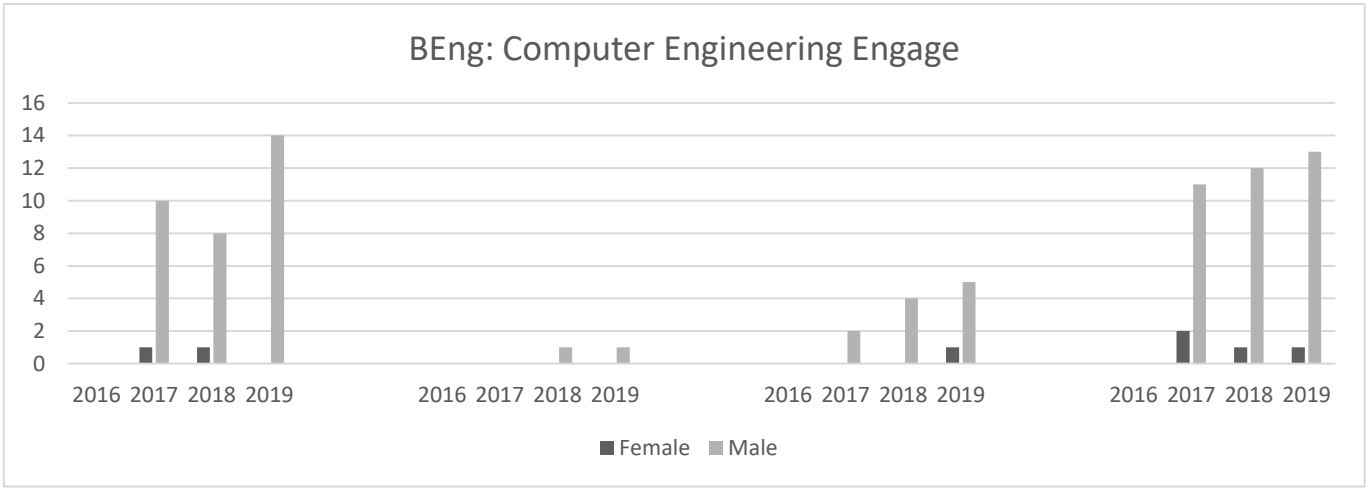
Student registration numbers for the years 2016 to 2019 for the degree BCom: Informatics



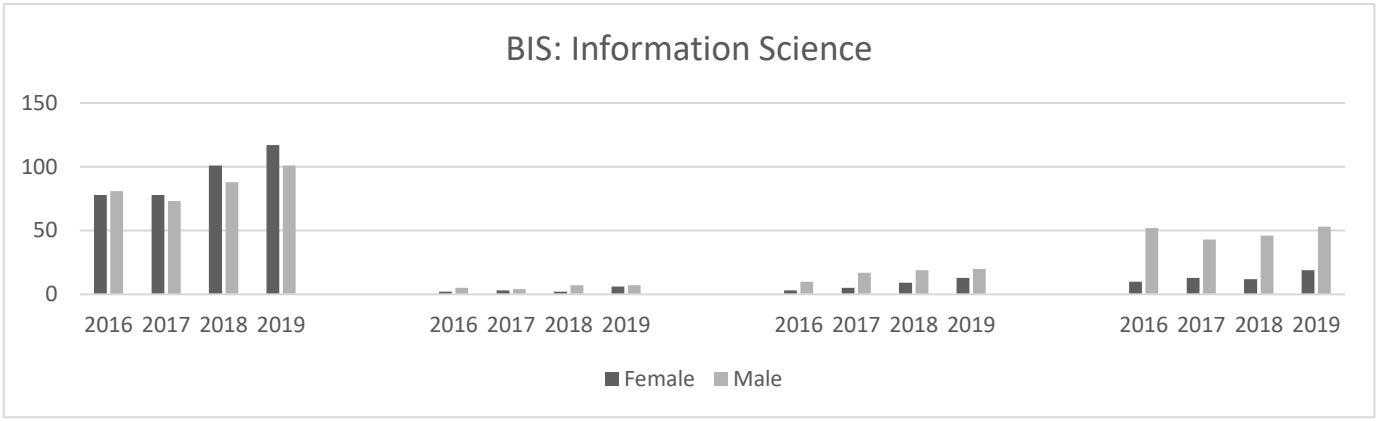
Student registration numbers for the years 2016 to 2019 for the degree BEng: Computer Engineering



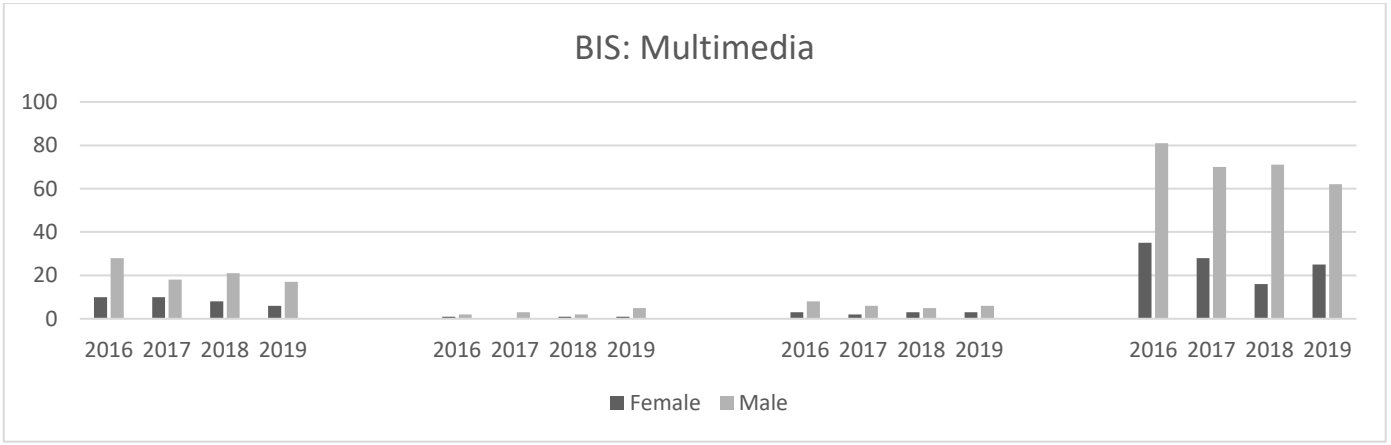
Student registration numbers for the years 2016 to 2019 for the degree BEng: Computer Engineering ENGAGE



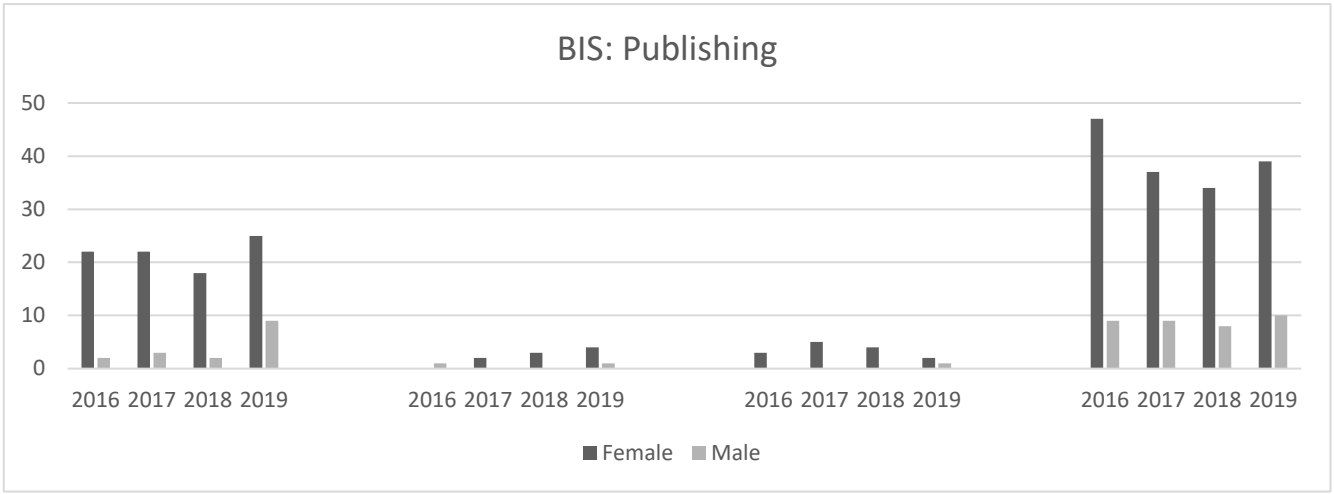
Student registration numbers for the years 2016 to 2019 for the degree BIS: Information Science



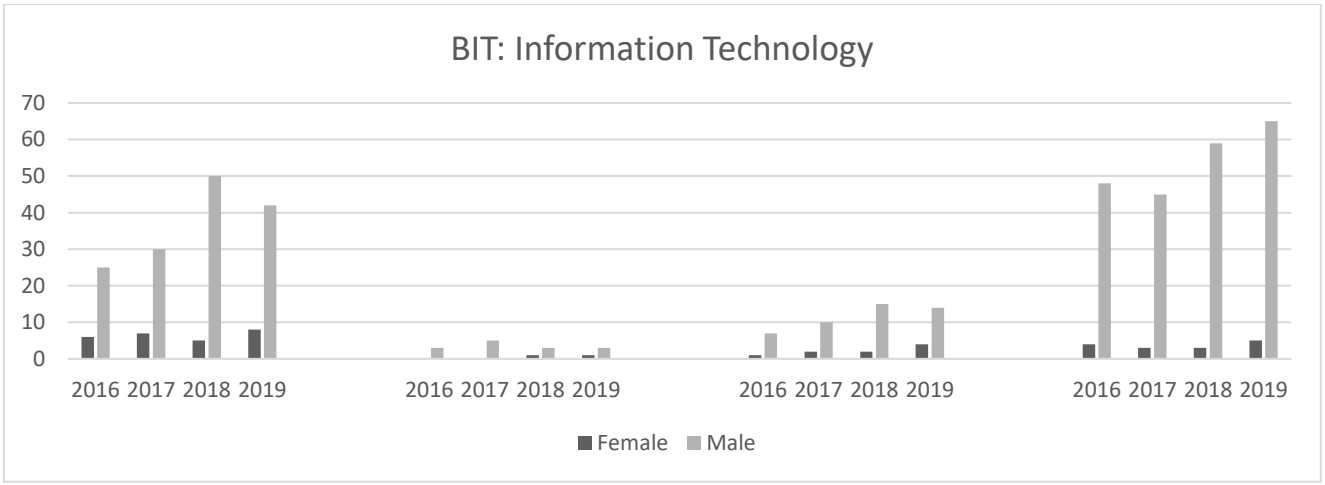
Student registration numbers for the years 2016 to 2019 for the degree BIS: Multimedia



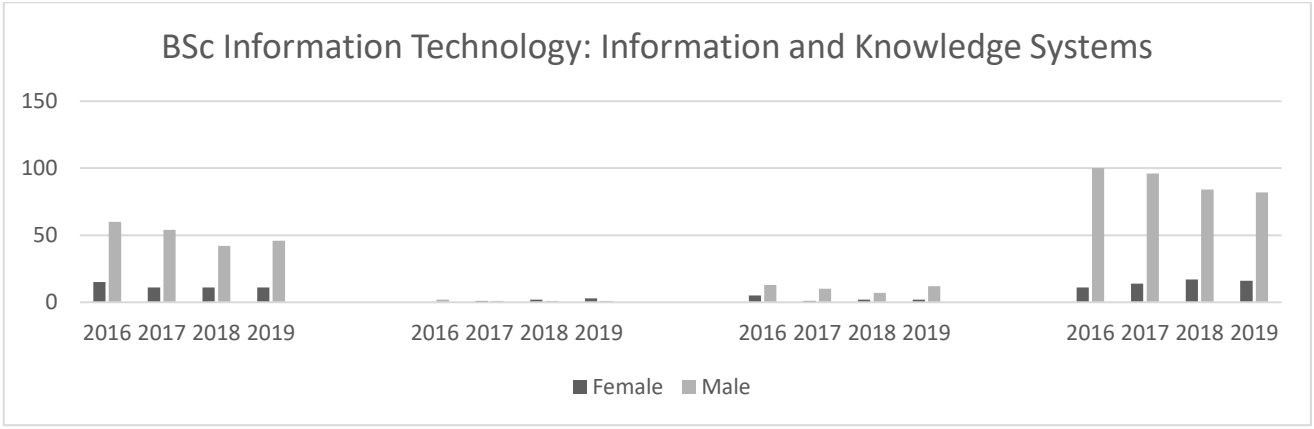
Student registration numbers for the years 2016 to 2019 for the degree BIS: Publishing



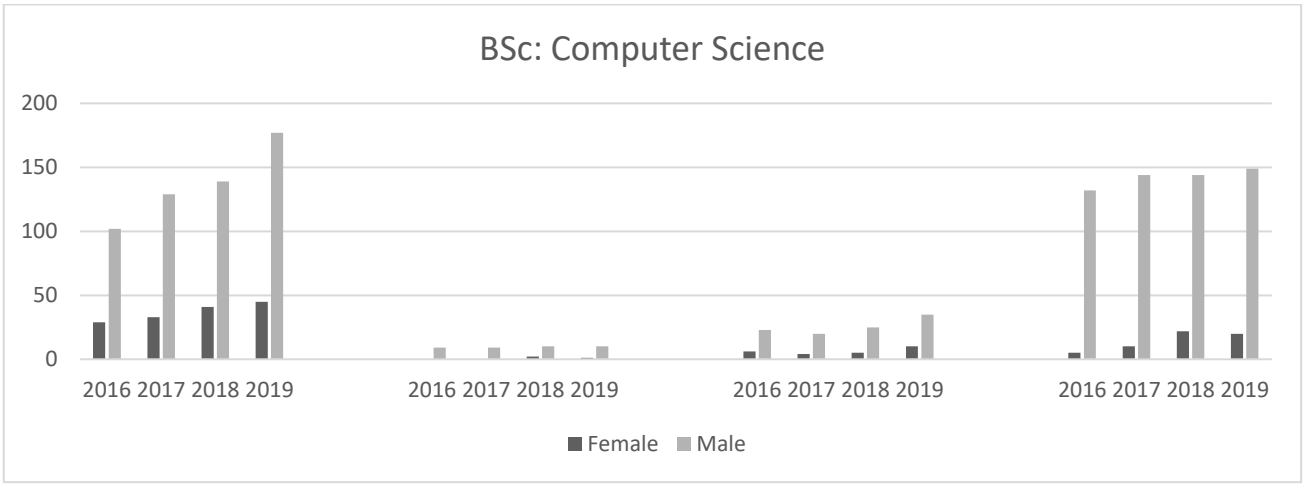
Student registration numbers for the years 2016 to 2019 for the degree BIT: Information Technology



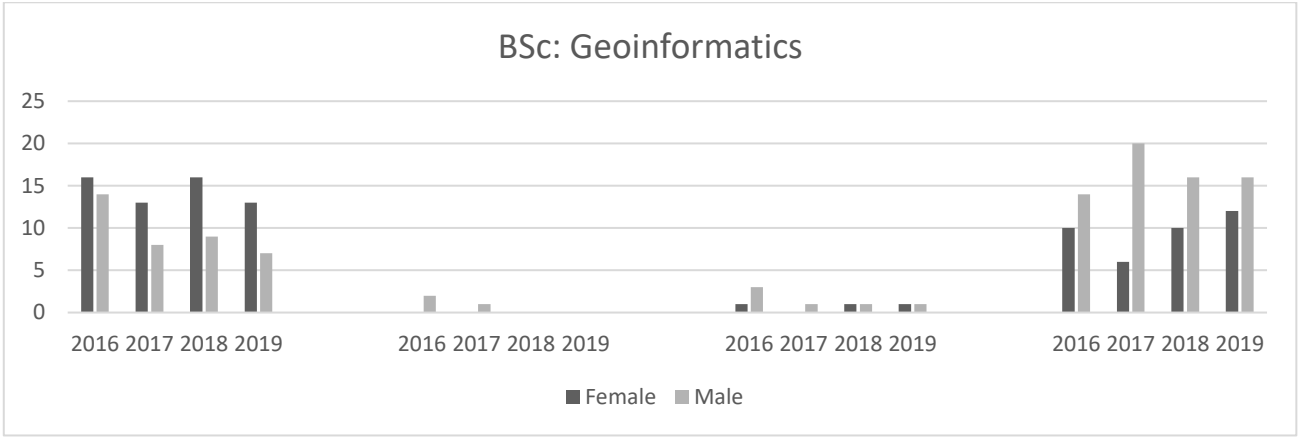
Student registration numbers for the years 2016 to 2019 for the degree BSc Information Technology: Information and Knowledge Systems



Student registration numbers for the years 2016 to 2019 for the degree BSc: Computer Science



Student registration numbers for the years 2016 to 2019 for the degree BSc: GeoInformatics



APPENDIX J: JOURNAL PAPERS (BY JOURNAL NAME) ON GENDER AND IS THAT WERE PUBLISHED BETWEEN 2012 AND 2020

This is a list of the 37 journal papers from Table 11: Journal papers (by journal name) on gender and IS that were published between 2012 and 2020., but presented in the same way as the list of 132 papers in Trauth (2013). In the column "Focus on gender research", ISWF indicates that the paper focuses on aspects of the IS workforce. The term "IT use" indicates that the paper reports on the use of information technology. In the column "Role of gender theory", the term "Guiding" indicates that the paper used the stated gender theory as a guide in the study. The term "Resulting" means that the study resulted in the said theory.

Author	Focus of gender research	Relationship to gender theory	Type of gender theorising	Name of gender theory	Role of gender theory
Alam & Imran, 2015	ISWF	Gender atheoretical			
Annabi and Lebovitz, 2018	ISWF	Gender and IS theory	Explicit	IDT	Guiding
Armstrong, Riemenschneider and Giddens, 2018	ISWF	Gender and IS theory	Explicit	Model of barriers to women in IT - extended	Guiding
Baglione, Harcar & Spillan, 2017	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Chiu, 2012	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Brooks, Hardgrave, O'Leary-Kelly, McKinney & Wilson, 2015	ISWF	Gender atheoretical			
Chen & Sharma, 2015	IT use	Gender and IS theory	Explicit	Learning theories	Guiding
Craig, 2016	IT use	Gender and IS theory	Explicit	Evaluation framework to evaluate gender and computing interventions	Resulting
Dhar-bhattacharjee and Richardson, 2018	ISWF	Gender atheoretical	Implicit	Gender essentialism	Guiding
Fehrenbacher, 2017	ISWF	Gender atheoretical			
Flick, 2015	ISWF	Gender atheoretical			

Author	Focus of gender research	Relationship to gender theory	Type of gender theorising	Name of gender theory	Role of gender theory
Foth, 2016	ISWF	Gender atheoretical			
Fothergill *et al.*, 2019	ISWF	Gender and IS theory	Explicit	Gender intersectionality	Guiding
Gallivan & Ahuja, 2015	ISWF	Gender atheoretical			
Godinho de Matos, Ferreira & Krackhardt, 2014	ISWF	Gender theory	Implicit	Gender essentialism	Guiding
Gorbacheva et al., 2019	ISWF	Gender atheoretical			
Ge, Kankanhalli & Huang, 2015	ISWF	Gender theory	Implicit	Gender essentialism	Guiding
Hansen & Walden, 2013	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Huang, Shi, Chen & Chow 2016	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Khalil & Seleim, 2012	IT use	Gender atheoretical			
Khedhaouria & Beldi, 2014	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Laumer, Maier, Eckhardt & Weitzel, 2016	IT use	Gender theory	Implicit	Gender essentialism	Guiding
LeRouge, Wiley & Maertz, 2013	ISWF	Gender theory	Implicit	Gender essentialism	Guiding
Krasnova, Veltri, Eling & Buxmann, 2017	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Lin, Featherman & Sarker, 2017	IT use	Gender and IS theory	Explicit	Expectation confirmation model and IS continuance and social role theory	Guiding
Mishra, Ostrovska & Hacaloglu, 2017	ISWF	Gender theory	Implicit	Gender essentialism	Guiding
Molnar & Hava Muntean, 2015	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Newbery, Lean & Moizer, 2016	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Newman, Browne-Yung, Raghavendra, Wood & Grace, 2017	IT use	Gender (disabilities) theory	Implicit	Bourdieu's critical theory	Guiding
Nisha, Iqbal, Rifat & Idrish, 2017	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Oreglia & Srinivasan, 2016	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Park, Lee & Shin, 2015	IT use	Gender atheoretical			

Author	Focus of gender research	Relationship to gender theory	Type of gender theorising	Name of gender theory	Role of gender theory
Pozzebon, Mackrell & Nielsen, 2014	IT use	Gender theory	Explicit	Structuration theory, diffusion of innovations theory, gender relations theory	Guiding
Reid & Thomas, 2017	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Smith, Mendez & White, 2014	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Trauth, 2013	IT theorising - The paper on which this study is based				
Trauth, Cain, Joshi & Kvasny, 2016	ISWF	Gender and IS theory	Explicit	IDT	Guiding
Venkatesh, Sykes & Venkatraman, 2014	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Venkatesh, Windeler, Bartol & Williamson, 2017	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Windeler & Riemenschneider, 2015	ISWF	Gender (minority) theory	Explicit	Affective events theory and social exchange theory	Guiding
Wijayawardena, Wijayawardena & Samaratunge, 2016	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Xu, Xu & Li, 2015	IT use	Gender theory	Implicit	Gender essentialism	Guiding
Yeganehfar *et al.*, 2018	ISWF	Gender theory	Implicit	Gender essentialism	Guiding
Zhang, Zhao, Lu & Yang, 2016	IT use	Gender theory			

APPENDIX K: JOURNAL PAPERS ON THE IS WORKFORCE, EMPLOYING EXPLICIT GENDER AND IS THEORISING, THAT WERE PUBLISHED BETWEEN 1992 AND 2020

Author	Relationship to gender theory	Name of gender theory	Role of gender theory
Igbaria & Baroudi, 1995	Gender theory	Gender bias in job performance assessment	Guiding
Igbaria & Chidambaram, 1997	Gender theory	Gender in human capital theory	Guiding
Panteli et al., 1999	Gender and IS theory	Gender occupational segregation in IT the industry	Resulting
Ahuja, 2002	Gender and IS theory	Model of barriers to women in IT	Resulting
Gallivan, 2004	Gender and IS theory	Model of barriers to women in IT	Guiding
Joshi & Schmidt, 2006	Gender theory	Gender role theory	Guiding
Riemenschneider, Armstrong, Allen & Reid, 2006	Gender and IS theory	Model of women's voluntary IT turnover and workplace barriers	Resulting
Armstrong, Riemenschneider, Allen & Reid, 2007	Gender and IS theory	Model of women's thoughts about work-family conflict	Resulting
Timms, Lankshear & Anderson, 2008	Gender theory	Model of factors influencing female participation in ICT	Guiding
Guzman & Stanton, 2009	Gender and IS theory	Occupational culture including gender	Resulting
Panteli, 2012	Gender theory	Community of women returning to IS work	Resulting
Armstrong, Riemenschneider and Giddens, 2018	Gender and IS theory	Model of barriers to women in IT - extended	Guiding
Fothergill et al., 2019	Gender and IS theory	Gender intersectionality	Guiding
Björkman, 2005	Gender theory	Feminism	Guiding
Kvasny, Greenhill & Trauth, 2005	Gender theory	Feminist standpoint theory	Guiding
Adam, Griffiths, Keogh, Moore, Richardson & Tattersall, 2006	Gender theory	Critical feminism	Guiding
Reid, Allen, Armstrong & Riemenschneider, 2010	Gender theory	Critical feminist theory	Guiding

Author	Relationship to gender theory	Name of gender theory	Role of gender theory
Harvey, 1997	Gender and IS theory	Social construction of gendered technology	Guiding
Woodfield, 2002	Gender theory	Social shaping of gender	Guiding
Harris & Wilkinson, 2004	Gender and IS theory	Social shaping of gender and technology	Guiding
Corneliussen, 2005	Gender theory	Social shaping of gender	Guiding
Tapia, 2006	Gender theory	Social construction of gender	Guiding
Joshi & Kuhn, 2007	Gender theory	Social construction of gender roles	Guiding
Kuhn & Joshi, 2009	Gender theory	Social construction of gender roles	Guiding
Lang, 2012	Gender and IS theory	Socio-cultural construction of gender norms	Guiding
Windeler & Riemenschneider, 2015	Gender (minority) theory	Affective events theory and social exchange theory	Guiding
Adya & Kaiser, 2005	Gender and IS theory	IT career choice model	Resulting
Croasdell, McLeod & Simkin, 2011	Gender and IS theory	TRA applied to gender	Resulting
Clayton, Beekhuizen & Nielsen, 2012	Gender and IS theory	IT career choice model	Guiding
Trauth, 2002	Gender and IS theory	IDT	Resulting
Quesenberry, Trauth & Morgan, 2006	Gender and IS theory	IDT	Guiding
Trauth & Howcroft, 2006	Gender and IS theory	IDT	Guiding
Howcroft & Trauth, 2008	Gender and IS theory	IDT	Guiding
Trauth, Quesenberry, Huang & McKnight, 2008	Gender and IS theory	IDT	Guiding
Trauth, Quesenberry & Huang, 2009	Gender and IS theory	IDT	Guiding
Kvasny, Trauth & Morgan, 2009	Gender and IS theory	IDT	Guiding
Quesenberry & Trauth, 2012	Gender and IS theory	IDT	Guiding
Ridley & Young, 2012	Gender theory Gender and IS theory	IDT, gender essentialism, social shaping of gender	Guiding
Trauth, Cain, Joshi & Kvasny, 2016	Gender and IS theory	IDT	Guiding
Annabi and Lebovitz, 2018	Gender and IS theory	IDT	Guiding