

# **The Under-Representation of Women in Third Level Computer Science Courses in Ireland**

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Information Systems

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## Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work and has not been submitted as an exercise for a degree at this or any other university. I further declare that this research has been carried out in full compliance with the ethical research requirements of the School of Computer Science and Statistics.

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## **Abstract**

This dissertation examines the barriers that discourage women from studying Computer Science at third level institutions in Ireland and what can be done to reverse the trend.

A review of the current situation in Ireland identified that there is an under-representation of female students in third level Computer Science courses. Over the past six years, the ratio of males to females has remained at 5:1 with girls only accounting for 15 per cent of all Computer Science students. Due to the extensive growth of the computing industry in Ireland in recent years, the issue of a gender imbalance in Irish based computing jobs is becoming an ever increasing concern.

The research was conducted by means of an online survey of 142 Irish second level students who were preparing to finish secondary school. Semi-structured interviews were also held with six Career Guidance Counsellors from Irish secondary schools.

The data collected were analysed to gain insights into the barriers that are preventing women in Ireland from going on to study Computer Science at third level and what the potential solutions could be to reverse the trend.

The findings of this research indicates that poor self-efficacy, lack of role models, curricula and negative stereotypes/culture are some of the barriers that are stopping female students in Ireland applying to study Computer Science at third level.

Potential solutions are to change the curriculum in Irish secondary schools to offer Computer Science as a subject; to introduce a partnership program between secondary schools and third level institutions and Industry; and offering more support to Career Guidance Counsellors.

**Keywords:** Under-representation, Stereotypes, Gender, Computer Science

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## Abbreviations

ASTI	Association of Secondary Teachers of Ireland
CAO	Central Applications Office
CAQDAS	Computer Assisted/Aided Qualitative Data Analysis Software
CS	Computer Science
CSO	Central Statistics Office
DES	Department of Education and Science
ENIAC	Electronic Numerical Integrator and Computer
ERSI	Economic and Social Research Institute
HEA	Higher Education Authority
ICT	Information and Communications Technology
IEEE	Institute of Electrical and Electronics Engineers
IMDb	Internet Movie Database
IT	Information Technology
OECD	Organisation for Economic Cooperation and Development
STEM	Science, Technology, Engineering and Mathematics
WAVES	Women Accepted for Volunteer Emergency Service
WITI	Women in Technology International

## CHAPTER 1 INTRODUCTION

“The most dangerous phrase in the language is,  
‘We’ve always done it this way!’”

Grace Hopper

### 1.1 Introduction

In current recessionary times, many economic sectors are slowing down and there is regular news of redundancies and of people emigrating from Ireland. Unemployment is currently at 12 per cent (Central Statistics Office, 2014), yet there is one area that is defying the trend and that is the Information Technology (IT) sector.

Ireland is a technological hub that attracts many of the top international IT companies such as Google, Microsoft, Intel, Facebook, Twitter etc. to set up their European headquarters here. These companies create thousands of job opportunities and contribute financially to the Irish economy. In 2012, there were an estimated 68,280 Information and Communication Technology (ICT) professionals working in the sector and in ICT occupations across other sectors of the economy. This is expected to increase by 5 per cent every year for the next six years (Expert Group on Future Skills Needs, 2013).

In 2008, the Expert Group on Future Skills Needs also reported on the future demand for ICT skills. It highlighted the risk that demand could potentially exceed domestic supply (Expert Group on Future Skills Needs, 2008). This forecast has become a reality and, currently, demand for qualified ICT people outstrips supply. Many companies in Ireland are unable to find the right candidates with the correct qualifications or experience to fill the vacant roles they have on offer.

A survey of IT companies in 2013 highlighted the fact that there were more than 4,500 vacant IT jobs in Ireland (Fasttrack to IT, 2013). One of the main findings from their survey was that if these jobs cannot be filled in Ireland, the roles may have to be relocated to other countries where the skillset is readily available.

The Irish Government, along with other stakeholders, has recognised that the technology sector is crucial to Ireland's economic growth. An ‘Action Plan for ICT’ was released in 2012, with one of its main aims being to double the number of graduates from honours degree ICT programmes to 2,000 by 2018 (Department of Education, 2012).

The IT skills shortage was also a main focus point in the Government's 'Action Plan for Jobs 2013' report with one of its main goals being to "make Ireland the most attractive location in the world for ICT Skills availability ensuring continued success of ICT sector" (Department of Jobs, Enterprise and Innovation, 2013, p.27). The report concentrates on initiatives to improve the awareness of ICT graduate conversion courses and to include ICT skills in the Springboard programme which offers free college places to people who are unemployed.

While all invested stakeholders point to the IT skills shortage in Ireland, they have missed a vital action point that would help to alleviate the problem: the issue of the under-representation of women in the IT and computing industry. While the 'ICT Action Plan' report briefly mentions the issue, "participation by female students, in particular, needs to be increased and a target of increasing female acceptances onto ICT related programmes from 15% to 25% is being established" (ICT Action Plan, 2012, p.8), they have failed to actually address the fundamental issue of female representation.

Acceptances by the Central Applications Office (CAO) to study Computer Science courses in 2103/2014 at Irish third level institutions comprise of 6.9 per cent of total acceptances (Higher Education Authority, 2014a). This figure has been steadily rising in recent years. However, female representation on these Computer Science courses is only at 15 per cent (Higher Education Authority, 2014b). The low numbers of women aspiring to a career in Computer Science is a very frustrating issue for Ireland and many other countries around the world. "The wastage, as regard human resources, if one ignores 50 per cent of the population, as well as the loss of potential diversity and balance in the work force, with the concomitant low level of customer satisfaction, should be apparent to all" (Lane, 1997, p.52). Women bring a different perspective to innovation and problem solving and can ensure that concerns unique to women will not be overlooked. This will ultimately result in products that are designed to be more representative of all users. Women also tend to be more social orientated than men (Diekmann et al, 2010), so they can easily mix their technical skills with social and communication skills which are crucial when dealing with ICT in a business environment. This is in line with what companies seek from their employees as suggested by the report from 'FIT - Fast track to IT' which identified demand for technical people with other skills, such as teamwork capabilities, good written and verbal communication skills, leadership ability and good customer focus (Fast track to IT, 2013).

If the untapped potential of women continues to be ignored and under-utilised, this will have an adverse major impact on Ireland’s economic future. Women are needed in Computer Science to ensure that Ireland continues to prosper as a technology hub and remains an attractive centre for technology companies to locate and remain here. With the current downturn and poor economic climate, this deficit situation cannot be ignored.

## 1.2 The Current Situation

Ireland has a good reputation for the level and quality of its education system. Education is free at all levels in Ireland meaning that everybody has an equal opportunity to proceed to higher levels of education. The Organisation for Economic Cooperation and Development (OECD) reviewed the educational status of people in 34 member nations (OECD, 2013). This report shows that Ireland ranks very high in terms of the proportion of adults who have achieved a third level qualification, 47 per cent of all 25 - 34 year olds hold tertiary qualifications giving Ireland a ranking of 5<sup>th</sup> out of 36 countries (Table 1.1). Similarly, Ireland ranks high for graduation rates with 89 per cent of today's young people expected to complete upper secondary education in their lifetime and 43 per cent are expected to complete university education (tertiary-type A) in their lifetime.

TABLE 1.1 Percentage of Population that has attained Tertiary Education (OECD, 2013)

Indicator	Ireland		OECD Average		EU21 Average		Rank among OECD countries and other G20 countries*
	2011	2000	2011	2000	2011	2000	
Percentage of population that has attained tertiary education							
25-64 year olds	38%	22%	32%	22%	25%	20%	12 of 36
30-34 year olds	49%		39%		37%		6 of 34
25-34 year olds	47%	30%	39%	26%	36%	24%	5 of 36
55-64 year olds	23%	13%	24%	15%	21%	14%	20 of 36

The 2011 Census of Population (Table 1.2) shows that more women than men obtain higher level qualifications. In total, 413,275 women aged 15 years and over, hold a third level degree or higher qualification, while the number of men with similar qualifications

was significantly lower at 326,735. In addition, the number of women currently studying at non-degree third level is 75,763 compared to 59,359 men. While the number of male students is catching up, the trend continues and there are currently 82,903 women compared to 81,595 males studying at Irish third level institutions. Figure 1.1, shows how strongly women are represented at third level.

TABLE 1.2 – Highest Education Level for Population aged 15 Years and Over (CSO, Census of Population 2011)

Population Aged 15 Years and Over (Number) by Age Group, Highest Level of Education Completed, Sex and Census Year	
<b>2011</b>	
<b>All Ages</b>	
Third level non-degree	
Male	59,359
Female	75,763
Third level degree or higher	
Male	326,735
Female	413,257

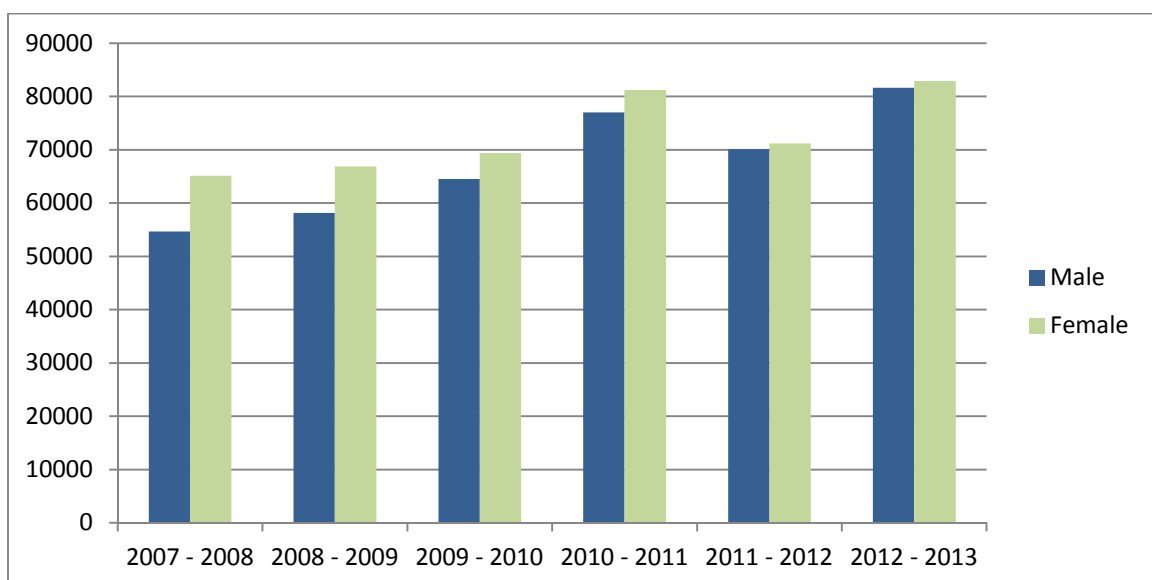


FIGURE 1.1 Total Numbers of Third Level Enrolments per Year (HEA, 2013)

Although there are more women studying at third level, this trend is not replicated in Computer Science courses. In the 2013/2014 academic year, only 15 per cent of new

entry students into Computer Science courses were female (Higher Education Authority, 2014c).

Figure 1.2 shows that the number of male students studying Computer Science has been rising steadily, almost doubling in the last six years. This coincides with the growth of the information industry and indicates a positive response to the rising demand for a highly skilled computing workforce in Ireland. Unfortunately, the number of female students enrolling into Computer Science courses is worryingly low and has remained relatively static over the last six years. This has resulted in a major gender imbalance among computing undergraduates.

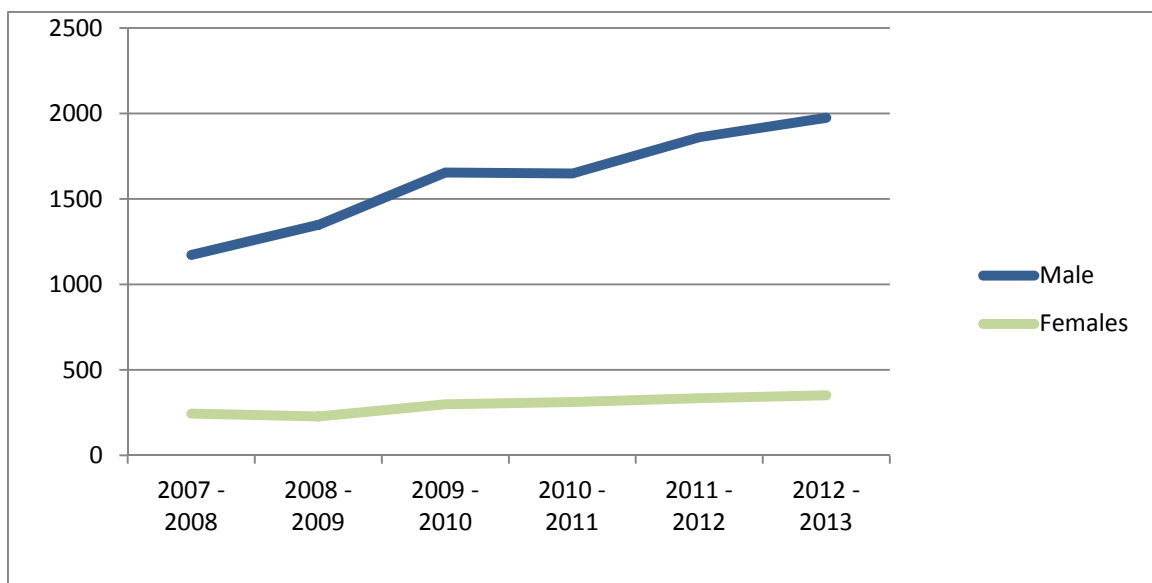


FIGURE1.2 - Yearly Computer Science Enrolments in Ireland (HEA, 2014)

The discrepancy between the numbers of women/men studying computing is a global issue that continues to concern IT professionals and educators. Research suggests a range of explanatory factors: women lack confidence; negative stereotype; male orientated culture; lack of appropriate role models etc. that contribute to this inequality. Despite this concern by stakeholders, the issue continues to exist.

One response is: 'why does it matter if there is a gender disparity in the Computer Science field?' One opinion is that women do not enter the discipline because they do not like it or are not particularly good at. While this may be a valid statement for any industry, the research suggests that women would bring a diverse perspective on creativity and innovation and a host of other benefits to the IT industry (Margolis and Fisher, 2003). A diverse workforce would "maximise the vibrancy and creativity of the ideas it produces"

(Clarke-Hayes, 2010, p. 27) and bring a competitive edge to continuous innovation and the introduction of new products (Hong and Page, 2004).

### **1.3 Motivation**

As a woman who studied Computer Science and Software Engineering for my undergraduate degree and subsequently worked in the industry since graduating, the topic of Women in IT and the gender imbalance has always been of great interest to me. I was one of a few young women on the course and I remember feeling very much out of place after my six years in an all-girls convent school. I also felt that the majority of the boys in my year had already been exposed to computers, or were naturally good at computing. Hence I was automatically playing 'catch-up' - something I had never experienced before. I worked hard and I qualified with a first class honours degree. To this day, years later, I still feel like a fraud and that I should not be working in IT, that it was just a stroke of luck that I got my degree and it was an absolute mistake that I came within the top three of the class. This feeling is known as 'imposter syndrome', where people, especially women, are unable to recognise their accomplishments and feel that they are down to luck or timing (Clance and Imes, 1978).

### **1.4 Research Question**

The main area of research for this dissertation is to study "Why are there are so few female students applying to third level Computer Science courses in Ireland?" For the purpose of this paper the term 'Computer Science' encompasses courses such as Computer/Computing Science, Computer Applications, Computational Thinking, Multimedia, Mobile and Web Development, Software Engineering, Information Technology, Computing and Computing in Games Development that are on offer in various Irish third level institutions at Level 6 (Certificate), Level 7 (Diploma) and Level 8 (Degree)

### **1.5 Goals and Objectives**

The aim of this dissertation is to understand why girls are not choosing to study Computer Science and Information Technology at third level institutions in Ireland. In order to undertake the research, the following objectives were identified:



- Identify the main barriers that discourage women from studying Computer Science at third level institutions in Ireland
- Recommend practical measures that can be put in place to reverse the trend

## **1.6 Contribution**

Much research has been undertaken on the low numbers of women in the IT and computer industry but the majority of this research is focused on USA. This research explores why girls are not choosing to study Computer Science at Irish third level institutions.

Ireland has become a 'knowledge based society' and people with IT skills are key to the growth of the Irish economy. Forfás, Ireland's policy advisory board for enterprise, trade, science, technology and innovation, reported that "the ICT sector is of strategic importance to the Irish economy both in terms of the numbers of highly skilled professionals employed and its significant contribution to Irish exports performance" and that one of their main goals was to "attract more talent with the right aptitude to careers in ICT, especially women" (Expert Group on Future Skills Needs, 2013). This research contributes to this objective and is appropriate to all stakeholders such as schools, universities, the Government and industry.

## **1.7 Overview of Dissertation**

The dissertation is organised as follows:

Chapter 1 introduces the research question and the aims and objectives of this study. It gives an overview of the research area and the background of the project.

Chapter 2 reviews and analyses the relevant academic literature on women in IT. It traces women's contribution throughout the history of computing and the different factors contributing to the under-representation in the computing industry and at third level.

Chapter 3 looks at the research methodologies that were chosen to conduct this study, outlining how the research was carried out and how ethical considerations were addressed. The chapter also reviews the difficulties that were encountered and the lessons learned.

Chapter 4 presents the findings of the research study. It details the results of the survey with sixth year students and the outcomes from the semi-structured interviews with Career Guidance Counsellors.

Chapter 5 concludes by discussing the extent to which the original objectives and goals were achieved. It outlines the limitations and identifies a number of possibilities for future research into the under-representation of women in Computer Science at Third level in Ireland.

## **1.8 Research Timeframe**

This research was conducted between December 2013 and August 2014. The literature review was undertaken between December 2013 and February 2014. Approval for the online survey and semi-structured interviews was granted by the TCD School of Computer Science and Statistics (SCSS) Research Ethics Committee in March 2014. The online survey was conducted in April 2014 and interviews in May 2014. Data analysis spanned May and July 2014.

## **CHAPTER 2 LITERATURE REVIEW**

### **2.1 Introduction**

The under-representation of women in the Computer Science sector is a well-documented and researched issue and despite increases in the numbers of women in some of the other stereotypical male industries such as science and maths, Computer Science is not following the same trend. For some reason, it has struggled to entice women into the industry which is in contrast to all other STEM (Science, Technology, Engineering and Maths) disciplines (Clarke-Hayes, 2010).

This chapter commences with the role of women in the history of computing and reviews the various strands of research conducted on the topic, focusing on the factors contributing to the under-representation of women in the Computer Science sector, followed by the actions needed to address:

- Negative Stereotypes;
- Second Level Education;
- Career Influences;
- Confidence and Self-Efficacy;
- Gaming;
- Lack of Role Models.

Finally, the efforts of Carnegie Mellon University and Harvey Mudd College are reviewed as they are two institutions that have been successful in increasing the representation of women in Computer Science at third level. The successful efforts employed by these colleges could be emulated in order to improve the under-representation of women studying Computer Science at third level in Ireland.

### **2.2 Women's History in Computing**

Surprisingly, computing was not always the male-dominated industry familiar today. Women had a long history in computing and a very significant presence in the early days when they constituted, almost exclusively, the first programmers and operators of computers.

Ada Lovelace is recognised as the first female programmer. She worked with Charles Babbage on his mechanical computer back in the 1840s. She was an accomplished mathematician and foresaw that Charles Babbage's machine could go beyond the task of number crunching and that it could be used for other computational applications. Her vision eventually became a reality in the 1940s when there was a move away from 'number crunching' to the use of symbols and rules, what we acknowledge as a 'programming language' today (Fuegi and Francis, 2003).

During World War II (1939 – 1945), there were two revolutionary computing projects, the 'Colossus' in the United Kingdom and the 'Electronic Numerical Integrator and Computer' (ENIAC) in North America. Both of these projects had women at the forefront, operating the machines. The Colossus project was part of an allied effort to decode messages that were sent by Germany to Japan during the war. Women were recruited to work on Colossus from the Women's Royal Naval Service by interview and no previous mathematics or computer qualification was required. Since the Colossus project was top secret, these women did not know what they were being assigned to, yet they were perfectly able to operate the machines after the appropriate training (Abbate, 2012).

In contrast, women made a specific choice to work on the ENIAC project. ENIAC was an electronic digital computer designed to calculate artillery firing tables for the US army, a job that then required approximately 200 women or human computers as they were known, to do the job by hand. To program the ENIAC, the US army hired six women, four qualified mathematicians and two with prior experience in programming (Abbate, 2012). These women were at the forefront of technology. It was a choice they made because it excited and challenged them. In 1997, these six women were inducted into the Women in Technology Hall of Fame (WITI, 2014a).

Another very prominent and pioneering female computer scientist was Grace Hopper who earned her Master's and Doctorate Degrees in mathematics from Yale University before joining the US Navy WAVES (Women Accepted for Volunteer Emergency Service) program in December 1943. She became one of the first programmers of the Harvard Mark I computer, a computer built at Harvard University in 1944 to assist the US navy during World War II. Hopper went on to develop the first compiler for a computer programming language (Bunch and Hellemans, 1993). She was involved with the development of COBOL programming language and she is also accredited with coining

the ubiquitous computer term 'debugging' after finding that a real bug had caused a malfunction in the Harvard Mark I.

Grace Hopper was named an IEEE Fellow in 1962 "for contributions in the field of automatic programming" (IEEEGHN, 2014) and went on to win the first 'Computer Science Man of the Year' award in 1969 (Carter and Jenkins, 2001). In 1991, she was awarded the National Medal of Technology for her pioneering accomplishments in the development of computer programming languages that simplified computer technology and opened the door to a significantly larger universe of users (Office of Public Affairs, 2014).

Anita Borg is a more recent computer scientist who was a champion for tackling the issue of the under-representation of women in computing. Borg received her Doctorate in Computer Science from New York University in 1981. She co-founded the 'Grace Murray Hopper Celebration of Women in Computing' conference in 1994 to bring the research and interest of women in IT together. In 1997 she established the 'Anita Borg Institute for Women and Technology', a not for profit organization aimed at helping to introduce and retain women into IT (Anita Borg Institute, 2014). Borg was inducted into the Women in Technology Hall of Fame in 1998 (WITI, 2014b) and has been awarded several other accolades such as the 'Melitta Bentz Woman of Innovation Award' in 1999 and the 'National Organization for Women, Excellence in Education Award' in 2002 (Anita Borg Institute, 2014).

Marissa Mayer is currently one of the most prominent women in the world of computing. Marissa earned a Bachelor of Science degree in symbolic systems and a Master of Science degree in Computer Science with a specialization in artificial intelligence from Stanford University. She was one of the first female engineers hired at Google in 1999 and worked there for thirteen years before going on to become the CEO of the company Yahoo! Mayer is also one of only 23 women running a Fortune 500 company.

While women clearly have been involved in computing for at least 150 years, their history is well hidden, if not almost erased. Few of their achievements are known to the general public or even employees in the computing industry. Highlighting the history of women in computing and celebrating their contribution is critical to changing the current male-dominated culture that pertains in computing today.

### **2.3 Negative Stereotyping**

A considerable volume of literature suggests that one important reason for the under-representation of women in Computer Science is due to the perceived stereotypes of computer scientists and programmers and the resulting stereotype threat.

A stereotype can be defined as a “cognitive structure that contains the perceiver’s knowledge, beliefs and expectancies about some human group” (Hamilton and Troler, 1986, p.133 ) or “a fixed, often simplistic generalisation about a particular group or class of people” (Cardwell, 1996, p.227). Stereotype knowledge is something that is acquired early in childhood and is relatively resistant to change (Levy et al, 2008, Wilson et al, 2000). By three years of age, children can understand basic stereotypes; distinguish between males and females; and associate certain objects more strongly with one gender than with the other e.g. physical attributes, clothes and toys (Banse et al., 2010, Martin and Ruble, 2010). This sex-role typing starts when boys and girls are treated differently by their parents, peers and society, immediately from birth. Boys are labelled masculine and girls are labelled feminine by choices their parents make for them (Peretti and Sydney, 1984). Boys are dressed in blue and given toys such as cars and building blocks to play with, while girls are dressed in pink and are presented with much softer toys such as dolls and teddy bears.

Stereotype threat can be defined as “the immediate situational threat that derives from the broad dissemination of negative stereotypes about one’s group – the threat of possibly being judged and treated stereotypically, or possibly self-fulfilling such a stereotype” (Steele and Aronson, 1995 p.798) or “the anxiety felt in evaluative context (tests, public speaking, etc.) by people who identify with groups about which a negative stereotype exists because they are concerned they might confirm the stereotype about their group or themselves” (Skelton et al., 2006 p.313). When there is a situation where stereotype threat is present, people affected by the negative stereotype can underperform relative to their ability (Steele, 1997).

This is shown in a study by Spencer et al. (1999) where men and women were told that a difficult maths test has shown gender differences in past results. With this information, women subsequently performed worse than men on the test. When participants were told that there were no past gender differences in results, women performed similarly to men. Along with the negative impact on performance, stereotype threat can also influence career choices (Shapiro and Williams, 2012).

It is well documented that people who study or work in the area of Computer Science and Information Technology fall victim to a number of negative stereotypes such as 'geeky', 'nerdy', 'anti-social' and that the IT culture is perceived to be male-dominated. The image of a computer scientist is somebody who is: male, unattractive, pale, thin and wears glasses (Mercier et al., 2006); to be very technology-orientated (Margolis and Fisher, 2003); have very little interest in people (Diekman et al., 2010); and socially awkward and obsessed with computers (Margolis and Fisher, 2003). This image does not resonate well with women, who tend to be more social-orientated than technology-orientated (Diekman et al., 2010) and "the predominately masculine characteristics conjured by stereotypical images of computer scientists may deter women from becoming interested in the field" (Cheryan et al., 2013 p.58). IT can be portrayed as an industry where only a certain type of person who meets the stereotype will fit in and succeed which is unfortunate since many computer related jobs are people-orientated (Clarke and Teague, 1994).

Research suggests that to overcome the problem of the popular misconceptions of Computer Science, it is crucial to introduce Computer Science to girls before the negative stereotypes have set in. "Females indicate that they want to be with people, they dislike the idea of sitting in front of a computer all day, and they think they dislike programming and hardware although most have no experience with either" (Carter, 2006 p.30). Computer Science is not about sitting at a computer all day. Computer Science jobs can be extremely varied and while the core of the discipline is to solve problems with IT, this cannot be done in isolation. Computer scientists can expect to be engaged in varied roles where they are required to do anything from travelling across the world for meetings with internal and external clients, designing business applications, to presenting ideas and solutions to senior management. Good communication skills, in tandem with technical skills, are essential to Computer Science roles. As a study by Graham and Latulipe (2003) showed, if these skills could be demonstrated to girls before they choose their third level courses, it could greatly improve the rate of application for Computer Science courses. The authors emphasised the need to overcome the negative stereotype at an early stage. As part of their research, Graham and Latulipe (2003) held a computing seminar with young girls to show them what is involved when you work in Computer Science. The results showed a change in the participants' perceptions with comments such as "We aren't geeks", "Their jobs seem a lot more interesting", "CS scientists are ordinary people, not geeks", and "I realize now that many computer scientists work with people in teams and in social situations, rather than only alone with a machine".

## **2.4 Computer Science at Second Level Education**

Research by Scragg and Smith (1998) found that one reason for the paucity of women in the computing industry is because there is a problem getting them into university to study the subject in the first place. According to this study, women are not introduced to computers at an early enough age and this impacts on their career path choices when it comes to selecting courses to study at third level. By this stage, stereotypes have set in and girls have preconceived ideas of what type of person studies Computer Science.

There is no formal Computer Science subject available at primary or secondary schools in the Irish education system. Unfortunately, this has detrimental effects on the number of students, both male and female, that go on to study computing at third level. A historical review of ICT in Irish education by McGarr (2009) showed that there was an initiative back in the late 1970s and early 1980s to get Computer Science added to the curriculum as an independent subject. This resulted in the addition of an optional computer module to the Leaving Certificate Mathematics course in 1980 and an optional computer course added to the Intermediary Certificate in 1985 (McGarr, 2009). However, since these courses were optional, they failed to make any real impact and the direction of the courses changed from core Computer Science principals to become integrated with other subjects with a focus on computer literacy. This means that most young Irish school leavers never get the opportunity to experience what the subject of Computer Science is before making their career choices.

In recent years, there has been an increased awareness of the importance of IT by the Department of Education and Science (DES) through assigning large amounts of funding for Information and Communication Technology (ICT) in schools. In 1997, the 'Schools IT2000' initiative was launched with a government investment of over £40 million for new software, hardware, training and support. The main goal of the initiative was to provide every student with the opportunity to achieve computer and Internet skills to prepare them for the information society for when they leave school (Department of Education and Science, 1997).

A further €108 million was invested in the launch of the 'Blueprint for the Future of ICT in Irish Education 2001-2003' program to build on the work already done as part of Schools IT2000. Its main aims were to reduce computer/student ratios, increase network



connectivity and to fully integrate ICT into teaching (Department of Education and Science, 2001).

The 'Schools Broadband Plan' was launched in 2005 with an investment of €18 million and an additional €337 million proposed in the 'Investing Effectively in Information and Communications Technology in Schools, 2008-2013' strategy. This policy recognised that "a lack of sufficient and sustained investment over recent years has resulted in inadequate and ageing ICT equipment in schools, no provision for technical support and inadequate levels of broadband internet" (Department of Education and Science, 2008 p.i). The main goals were to improve: ICT Infrastructure; professional development needs for teachers and broadband for schools.

While the lack of Computer Science on the curriculum impacts on both male and female students, it ultimately alienates girls to a greater extent than boys. The latter tend to be involved with computers regardless of the level of exposure in the classroom since "video games and hours of tinkering and experimentation are the 'hook' that gets them interested in Computer Science" (Goode et al., 2008, p.93).

## **2.5 Influences on Career Choice**

Career choices for both boys and girls are influenced by a number of factors. Holland's (1996) Career Typology states that individuals choose certain careers because they are attracted to them and because the occupation will fulfil the needs of that person and can provide satisfaction to them. However, Holland does not take into consideration that some occupations are gender dominated and that this bias may be due to the expectations of society on what occupations women and men should hold (Ogowewo, 2010).

Parents can be among the greatest influences on their children. When parents show a positive interest with their children's education and extracurricular activities by providing praise and encouragement, they can motivate and create confidence in their children (Gonzalez-DeHass et al., 2005). However, research has shown that parents can hold a stereotypical view regarding the ability of their children, depending on their gender, and ultimately have opinions on what careers are suitable for them. (Tenenbaum and Leaper, 2003). Frome and Eccles (1998) suggest that this can be more pertinent in the case of mothers but not necessarily of fathers. Mothers are more influential when it comes to creating stereotypical gender ability ideas in girls and influence them to stay away from

maths, engineering and technology careers, while fathers have a more realistic idea of their children's abilities. These findings by Frome and Eccles are in line with earlier findings by Putnam and Hansen (1972) who showed that where fathers play an influencing role, their daughters go on to be successful even in stereotypical male careers.

Career Guidance Counsellors and other subject teachers also have a pivotal part to play in influencing girls and boys on their career choices. The role of the Career Guidance Counsellor is to "engage in personal, educational, and vocational counselling with clients throughout the lifespan, in the particular circumstances of their life" (Institute of Guidance Counsellors, 2007 p.3). Career Guidance is a mandatory part of the curriculum for Irish students in second level and a survey by Gibson (2003) showed that guidance counsellors exert a major influence on student's career choices in Ireland. Ogowewo (2010) showed that students who lacked self confidence in their ability, chose careers based on their gender rather than on ability. The study also showed that the role of the Career Guidance Counsellor is critical in such cases to encourage students to choose careers based on their ability.

The media and popular culture has an increasingly significant role to play in influencing people and reinforcing gender stereotypes. Using the very popular CBS television show, 'The Big Bang Theory' as an example of how people in science and technology are depicted in pop culture. The male protagonists of the show are scientists and engineers and are portrayed as very intelligent, geeky, nerdy and socially awkward men. In contrast to the men, the female protagonist is portrayed as a dumb, uneducated blonde girl who works as a waitress. She does however appear to be cool, fun, have lots of friends and great social skills - a complete contrast to the male characters. This very popular show only compounds the notion that only men are good at science and technology and hence conform to the geeky, nerdy stereotype. Over time, female supporting characters have been introduced into the show. These characters were all highly qualified, working in fields similar to the male characters, however, these characters also held the stereotypical traits associated with these fields such as geeky, uncool and socially awkward.

## **2.6 Confidence and Self Efficacy**

Low confidence levels and poor self-efficacy beliefs can impact on women's choices to study, enter or remain in a career in Computer Science. Self-efficacy beliefs are a

cognitive evaluation of an individual's ability to successfully perform tasks and reach goals (Bandura, 1993).

Numerous studies have found that women have lower levels of self-efficacy than boys when it comes to stereotypical male dominated subjects such as mathematics, engineering and computers (Beyer et al., 2003, Dickhäuser and Stiensmeier-Pelster, 2003) and that it is this lack of self confidence, not ability, that is the most significant difference between male and female science students (Margolis and Fisher, 2003).

Girls automatically expect to fail at tasks that they are unfamiliar with or perceive to be difficult (Oakes, 1990). This lack of self-efficacy in girls causes them to under-perform as shown in a study by Collins (1982) referenced in Bandura (1993) where children with positive self-efficacy performed better than children with self doubt, regardless of their actual ability.

Expectations of Computer Science students are very high and this can be discouraging for young women who may automatically feel they are not good enough (Margolis and Fisher, 2003). Even if girls do develop positive computer beliefs and apply to third level to study Computer Science, they can lose their confidence and interest in computers because of the unsupportive culture and environment they have entered (Margolis and Fisher, 2003).

This is also evident in a study carried out by Comber et al (1997) on the computer use and attitudes of 11-12 year old and 15–16 year old second level pupils in the UK. They found that, even at this age, girls had lower levels of self-confidence with computers than boys. The authors carried out the study again in 2003 to see if the attitudes had changed after the introduction of ICT into the school curriculum. They found that boys were still more confident in their use of computers, indicating that exposure to computers did not answer the problem of the lack of confidence among girls (Colley and Comber, 2003). These results are echoed in another study from Vekiri and Chronaki (2008 p.1400) who found “that the encouragement and expectations that parents express to their children are more important predictors of children's self-efficacy and value beliefs than children's own computer activities”. The authors concluded that supportive environments and cultures are more important than exposure. A study by Beyer et al (2003) also suggests that when women have supportive family and friends, they are more likely to enter and stay in a Computer Science course.

Confidence is crucial for women and, if not nurtured, can have detrimental effects. "It may decrease the likelihood that women will choose to major in CS and increase the likelihood that female CS majors will drop out of CS" (Beyer et al., 2003 p.52 ). Zeldin and Pajares (2000) found that for women to develop a confidence in themselves, it was crucial that others had to believe in them and show that they had confidence in them.

## 2.7 Gaming

Computer games are an excellent entry point for children to become familiar with computers. Children find it fun and exciting to play games on computers while subconsciously, they are learning skills such as logical thinking, problem solving and spatial recognition (Natale, 2002). Many video games allow for open source design development and encourage players to develop or modify the games. This is an excellent way of introducing people to computer programming and engineering as it is just an extension of a hobby.

Unfortunately, the gaming industry is notoriously male-dominated and possibly even sexist. It produces games that are mainly directed at the interest of young boys. Popular games include 'Grand Theft Auto', 'Assassin's Creed', 'Final Fantasy', 'Call of Duty' 'WWE' and 'Tomb Raider' (IMDb, 2014) with many of the main themes being male dominated sports, zombies, violence and assigation. Females are rarely represented in these games but if they are, they are represented by "a sprinkling of under-fed silicon-enhanced bad girls" (Moorman and Johnson, 2003 p.194) or depicted as the helpless victim who needs to be rescued by the male hero (Lynn et al., 2003).

Marketing paraphernalia is also aimed at the male buyer by depicting pictures of men in acts of war and violence. Even companies that are normally gender neutral in other software offerings, target games at the male market. In 2013, Microsoft released a letter as part of their marketing campaign for the Xbox One. The letter contained content such as:

*"Not sure if you've heard, but Xbox One is now available. That means we can start playing games like Dead Rising 3. I know, I know. You'd rather knit than watch me slay zombies, but hear me out on this. Xbox One is actually for both of us. Seriously"* (Kelly, 2013).

This sexist comment caused much controversy and was deemed offensive/condescending to women. Microsoft officially withdrew the content and apologised for causing offense (Kelly, 2013).

These themes and images completely alienate women from the gaming market. Not only is the gaming industry missing out on 50% of its potential market share, more importantly girls are missing out on the opportunity to become computer literate and interested in computers at a much earlier age. Ultimately, it is impacting negatively on the number of women who go on to study computing at third level. This is confirmed in a study by Natale (2002) who showed that 79 per cent of adult male computer professionals had played computer games as a child and that 71 per cent of adult male computer professionals claimed that their gaming experiences had influenced them to choose computing as a profession.

## **2.8 Role Models and Mentors**

A role model is “a person who serves as an example of the values, attitudes and behaviours associated with a role” (Cahoon & Aspray, 2006, p.156). When thinking of role models in the Computer Science and technology industry the names of people who are at the forefront of the exciting technologies are Steve Jobs from Apple, Bill Gates from Microsoft, Mark Zuckerberg from Facebook and Larry Page and Sergey Brin from Google, all of whom are male. These men are regularly discussed in the media and popularised as icons of the technology industry, thereby reinforcing the misconception that men are better than women when it comes to IT.

Male-dominated fields can be highly intimidating and unwelcoming places for females. Many girls who accept a place on third level Computer Science courses find themselves in a minority. This can be unsettling and can be further compounded if the majority of their lecturers are male also (Margolis and Fisher, 2003). It is widely accepted that exposure to successful females in Computer Science would show women that they can indeed be successful in the field (Lockwood and Kunda, 1997; Marx, Stapel, and Muller, 2005). Girls should be able to relate to female role models and it would promote confidence among them that they too can be successful in a Computer Science career. Female role models show that it is possible for women to succeed in this male-dominated industry.

However, Cheryan et al. (2011) argue that it is not that simple since it is not necessarily the gender of the role model that is important, but the stereotypes that the role model engages in. Their research shows that female role models are no more effective in increasing women's beliefs about their potential for success than male role models were. When women interact with a role model that has the stereotypical traits of a computer scientist such as geeky, nerdy and anti-social, they are less likely to succeed than if they interact with a non-stereotypical role model. "Role models in STEM, whether male or female, who embodied stereotypes that are incongruent with the female gender role undermined women's beliefs about their ability to be successful in STEM while leaving men's beliefs intact" (Cheryan et al., 2011).

Research by Canes & Rosen (1995) and Clarke-Hayes (2010) also questioned the need for, and support of, female faculty role models. They found that the increasing number of female faculty members has not positively impacted on the number of women studying Computer Science and suggests that role models alone may not be the answer.

While female faculty or female role models that display stereotypical traits may not increase the numbers of women in Computer Science, the impact of having a person to turn to should not be underestimated and this is where the role of mentoring is important. Mentoring can be defined as an experienced person offering information, support and guidance to a less experienced person (Campbell and Campbell, 1997). Mentors can be male or female - students will benefit regardless, as long as the mentors are: sincere and provide genuine encouragement (Townsend, 2002); good listeners, approachable, available, supportive and understanding (National Academy of Sciences, 1997). While the gender of the mentor does not affect the results, studies have shown that same sex mentors are preferable (Campbell and Campbell, 1997).

A study by Craig (1998) showed that women studying in an undergraduate business computing course who participated in a peer-mentoring programming were twice as likely to stay in University than those who did not participate in the program. The program was fully supported by Victoria University of Technology who allocated time and facilities to those participating. The mentors were female students in third and fourth year of the course as they could assist and support new students as they had already been through the experience. The retention rate for those participating in the program was 90 per cent while the retention rate for non-participants of peer-mentoring programming was only 45 per cent.

## **2.9 Success Stories – Carnegie Mellon and Harvey Mudd**

A number of colleges in the United States have focused on the under-representation of women in their Computer Science courses and have successfully intervened to increase the numbers.

Margolis and Fisher (2003) carried out an in-depth study at Carnegie Mellon University to examine the factors contributing to the under-representation of women studying computing. The study took place over four years and is based on multiple interviews with more than one hundred Computer Science students, classroom observations and discussions with university and high school faculty.

The gender-independent strategies formulated from this study resulted in the number of women enrolled in Computer Science at Carnegie Mellon University growing from 7 per cent to 42 per cent between 1995 and 2000.

Similarly, Harvey Mudd College quadrupled the percentage of female Computer Science majors from 10 per cent in 2006 to 42 per cent in 2010. This was accomplished by implementing three initiatives: a redesign of the introductory Computer Science course; sponsored trips to the Grace Hopper Celebration of Women in Computing annual conference and to provide opportunities for girls to complete real world research (Avarado and Dodds, 2010).

### **2.9.1 Key Effective Strategies Implemented**

The admissions policy in Carnegie Mellon gave preference to students who had previous computing experience. It was found that this policy was impacting negatively on the number of female students since girls were less likely than boys to have previous experience. The university changed its marketing and admission policies to remove this restriction which directly resulted in the recruitment of more women.

Carnegie Mellon held a summer school for high school Computer Science teachers to enable them to teach programming that would be gender neutral. This initiative helped to increase the number of girls taking high school Computer Science classes. The university created a partnership with high schools which also resulted in an increase in the number

of students, both male and female, who wanted to study Computer Science at the university.

Carnegie Mellon found that culture plays an important role within the Computer Science department. Stereotypical attitudes and behaviours can have a negative impact on attracting and retaining women. The university paid particular attention to the culture within the Computer Science department to ensure that no particular student group was dominating. It aimed to cater for not only the 'hard core techie' but also for the student who has an interest in the broader spectrum of computer application use in a harmonious environment.

Harvey Mudd redesigned their introductory Computer Science course to make it more appealing to a wider audience. The college changed from teaching the traditional Java programming language to a teaching Python. While the course covered the same theoretical concepts as before, students found Python easier to learn than Java. The college also split their introductory classes into two streams, one for students with prior Computer Science experience and one stream for students with little to no prior knowledge. The aim of this was to reduce the intimidation that students without previous experience can sometimes feel.

The Grace Hopper Celebration of Women in Computing conference is the world's largest gathering of women technologists who come together annually to discuss careers and research interests of women in computing. Harvey Mudd began inviting all female first year students to attend this conference. This opportunity enabled students to meet successful female role models, see the variety of jobs available to Computer Scientists and ultimately experience a welcoming culture.

Harvey Mudd introduced research opportunities during the Summer months for first year female students. Students were hired to work on ongoing projects in artificial intelligence, robotics and games development. This opportunity allowed students to immediately apply their Computer Science knowledge to real life problems, boost their confidence and deepen their interest in the discipline. Although the students had very little experience in the area initially, they made concrete progress on real research problems.



## **2.10 Literature Findings**

This chapter reviewed the literature in the area of women and Computer Science, with particular reference to the reasons why women choose to avoid studying the subject at third level. The history of women in computing was explored highlighting that it was not always the male-dominated environment that exists today. In fact, women were at the forefront of IT from its emergence. Existing literature indicates that there are a number of factors that contribute to the under-representation of women in the computing industry.

The portrayed image of people working in the IT industry has created a stereotype that women find hard to relate to. A computer scientist is typically depicted as somebody who is geeky, nerdy and unsocial. The resulting stereotype threat is impacting on women's career choices with regard to Computer Science.

There is no compulsory Computer Science course on the curriculum in primary or secondary schools in Ireland. All IT funding goes directly into software, hardware or support and while this creates an opportunity for all students to learn some basic computer skills, it does not promote or encourage students to study Computer Science at third level.

The literature review shows that there are a number of people who hold influencing roles in helping girls choose their career path. Parents play a very important part and can be among the most influential people in their children's life. However, parents, specifically mothers, are biased in relation to what they expect their children to be good at, depending on their gender.

The Career Guidance Counsellor is also a very important influencing factor. The counsellor can help encourage students to pick career paths based on their ability and not on their gender.

Popular culture, including magazines and TV shows, is very powerful at sending out messages to young people. The media often choose to portray the traditional gender stereotype in its communications, to be more easily understood and/or enjoyed by a larger audience. Unfortunately, this can create distorted images of reality and incorrectly shape the opinions and attitudes of recipients.

The confidence levels and self-efficacy of female students is much lower for subjects that are stereotypically male-dominated. Research suggests that measures need to be put in place to increase the confidence of young girls and to encourage and support them in the same way boys are.

Gaming is a multi-billion dollar industry that is predominantly aimed at a young male audience. Their marketing approach and game design is often sexist and can alienate women in a number of ways. Ultimately, such games do little to encourage women to play games or entice them to get into games design and development.

The shortage of female role models in the Computer Science industry has been cited as a reason why there are so few women choosing to study it. Female role models can inspire more girls to choose Computer Science as a career. However, if these female role models display stereotypical traits, the impact may be negated.

Carnegie Mellon University and Harvey Mudd College are examples of how third level institutions can successfully fight the gender disparities in Computer Science courses. Both colleges employed various initiatives which successfully increased the number of girls enrolling into their Computer Science program.

## **CHAPTER 3 METHODOLOGY**

### **3.1 Introduction**

Research involves asking questions, gathering information and then presenting the facts and figures. However, it is also the process of collecting, analyzing, and interpreting data in order to understand a phenomenon (Leedy and Ormrod, 2001). To conduct research, a number of factors need to be considered such as research philosophies, research approach, research strategy, research choices and timelines.

This chapter reviews the research methodologies and strategies considered as part of this research project. It provides the rationale for the methods chosen to carry out the research on why there are so few women applying to study Computer Science at third level in Ireland.

### **3.2 Research Philosophies**

A research philosophy forms the foundation to any research question. It can be defined as “the development of knowledge and the nature of that knowledge” (Saunders et al., 2009, p. 107). There are a number of business research philosophies available for consideration when carrying out a research project and the philosophy chosen depends mainly on the researcher and other practical considerations and constraints, such as time, location and costs. Researchers have diverse views on what is important and what is useful with respect to their particular research question.

The following research philosophies are widely accepted within business and social research:

- Positivism
- Interpretivism
- Realism
- Pragmatism

### **3.2.1 Positivism**

Positivism is an “epistemological position that advocates the application of the methods of the natural sciences to the study of social reality and beyond” (Bryman and Bell, 2011, p.15). The independent researcher collects data and uses methods of observation and measurement to describe the event. Positivists takes a “realist position and assume that a single, objective reality exists independently of what individuals perceive” (Hudson and Ozanne, 1988, p.509). Positivists assume that subjects can be taken out of their natural environment and observed in a controlled setting. They would then assume that the behaviour observed is representative of behaviour in the natural environment (Hudson and Ozanne, 1988).

### **3.2.2 Realism**

Realism uses a scientific approach for the gathering and development of knowledge. “The philosophy of realism is that there is a reality quite independent of the mind” (Saunders et al., 2009, p.114). Realism is similar to positivism in that a scientific approach should apply to the collection of data and to explaining or understanding these data. It also takes the view that there is an external independent reality, separate from the individual’s perceptions (Bryman and Bell, 2011).

There are two types of realism - Direct and Critical. Direct realism is where our senses portray the world as it is and we perceive objects as they are. “Through the use of appropriate methods, reality can be understood” (Bryman and Bell, 2011, p.17). Critical realism goes one step deeper and argues that the researcher’s conceptualization of reality is just a way of knowing that reality, that there is a distinction between the object and the terms used to describe and understand that object. Here, social conditioning impacts on the researcher’s approach to data collection which contrasts with the positivist approach where the researcher is independent in the role of data collection.

### **3.2.3 Interpretivism**

Interpretivism is the term used to describe the alternative view to positivism. It respects the differences between people as social actors and social objects and requires the researcher to understand the subjective meaning of social action (Bryman and Bell, 2011). The researcher needs to understand and see the world from the point of view of the

research subject and not to generalise and predict the causes and effects. It contrasts with positivism because the data collected are not value free since the researcher interacts with the human subjects of the research and this changes the perceptions of both parties (Walsham, 1995). The interpretivist researcher believes that many realities exist due to the many different and ever-changing perspectives of their subjects.

### **3.2.4 Pragmatism**

Pragmatism suggests that the approach the researcher takes is determined by the research question and that a mixed methods approach can be used to address different questions. A mixed methods approach is the term used when both qualitative and quantitative data collection and analysis techniques are used (Saunders et al., 2009). Quantitative methods are concerned with the numeric representation of data. These provide answers to questions of incidence and measurement (Tharenou et al., 2007).

Qualitative research usually refers to the written or spoken word rather than numbers and can be a product of all research strategies (Saunders et al., 2009) extending to visual methods such as reports, photographs, video etc. (Bryman and Bell, 2011). The mixed methods approach has been deemed appropriate by many (Curran and Blackburn, 2001; Tashakkori and Teddlie, 2003) since, in most cases, a simple quantitative-qualitative divide cannot always address the complex nature of the research question. Qualitative analysis provides rich detail and addresses the context, while quantitative analysis can answer the 'how much' and 'how many' questions (Tharenou et al., 2007). Pragmatic researchers recognise this and understand that every method has its advantages and limitations and that the different approaches can be complementary. The aim of using mixed methods is to maximise the strengths and minimise the weaknesses of each method. For example, the researcher may use face-to-face interviews to gather rich qualitative data and then use the results to develop an in-depth quantitative survey upon which statistical analysis can be undertaken.

A knowledge and understanding of all the research philosophies helps researchers decide on a research strategy. However, it is important to note that no one research philosophy is the best as they all have different qualities and merits. The key is to choose the best research philosophy to answer a particular research question.

### **3.3 Research Strategy**

A pragmatic research approach was adopted for this research to allow for both quantitative and qualitative data collection. Adopting an exclusively quantitative or qualitative method was deemed impractical in addressing the research questions.

The following two research methods were used:

1. An online survey of students in their sixth year, who are preparing to leave second level education, in order to understand their views on the subject of Computer Science;
2. Semi-structured interviews with Career Guidance Counsellors to understand the current practice of Career Guidance in Irish secondary schools, that may influence the selection of Computer Science as a third level study option.

### **3.4 Online Survey**

An online survey was chosen as one of the methods of gathering primary data. Survey research can be defined as “the process of collecting representative sample data from a larger population and using the sample to infer attributes of the population” (Nesbary, 2001, p.10). A survey is often used for exploratory and descriptive research (Saunders et al., 2009). The main aim of survey research is to accurately estimate the percentage of population that has a specific attribute by collecting data from a sample of the total population (Dillman, 2000).

In designing the questionnaire, it was decided to include a mix of pre-coded closed quantitative questions and open-ended qualitative questions to try to gather the views and perceptions of participants. Senior cycle students (sixth year) were the target population for the survey since they would have just gone through the third level application process in January 2014 and would be in the best position to answer questions associated with career and third level course choices.

The survey was distributed to both boys and girls over the age of eighteen in a number of selected schools. The survey was designed to ensure that no gender bias was introduced at any stage by framing questions that were gender neutral.

The objectives of the survey were to ascertain -

- proficiency in the use of IT or how 'Tech Savvy' respondents were;
- students' preconceptions of computer scientists;
- the key influences on students in terms of making career choices;
- whether or not students had applied to study Computer Science and why this was the case;
- students' experience, if any, with Computer Science;
- if students think that Computer Science should be introduced as a subject in second level schooling and their reasons.

### **3.4.1 Sample Population**

The research aim is to find out why girls are not choosing to study Computer Science at third level at the same rate as boys. The ideal sampling frame for this research would have been all schools registered with the Department of Education in 2014, using probability-based sampling, whereby all schools would have had an equal chance of being selected from the sampling frame. Unfortunately, due to time constraints and financial limitations, it was not possible to use this sampling method. Instead, a convenience sampling method was used, where relationships already existed with schools, to maximise the response rate and meet the research deadline. A variety of schools in Galway, Roscommon, Kildare, Westmeath, Longford and Dublin were asked to participate in the research in order to give a realistic representation of students in Ireland.

### **3.4.2 Survey Design**

The review of the literature produced a number of recurring variables that might influence the decision to study Computer Science at third level, namely:

- Negative Stereotypes
- Second Level curriculum
- Career Influencers
- Confidence and Self-Efficacy
- Gaming
- Role Models

These were then used to structure the survey questions.

The main points of consideration when designing the survey was to ensure that there was no bias in the wording of questions, the number of questions and time needed to complete the survey. Research by Galesic and Bosnjak (2009) suggests that longer surveys impact negatively on the response rate and the quality of the responses. Also, as participants would be completing the survey during school class time, it was imperative that the survey could be finished in a maximum of twenty minutes.

The questionnaire was created using an online survey tool called SurveyMonkey ([www.surveymonkey.com](http://www.surveymonkey.com)). This was chosen because it has many advantages over a paper-based survey. It is much faster, has a greater geographical reach and offers complete anonymity for the participant, since there is no interaction with the researcher. It also offers the ability to branch out and separate questions, depending on previous answers, thereby ensuring continuity and relevance for the participant (Rosenfeld et al., 1993) and (Tingling et al., 2003). There are some risks associated with using online surveys that should be noted. Research participants are limited to those that are computer literate, have access to a computer and/or the internet (Fricker and Schonlau, 2002).

The survey was piloted for feedback before it was distributed to schools. Pre-testing a survey helps to identify any problems or questions that do not make sense to participants. The survey was pre-tested on five people – three students who met the criteria of target audience and two peers of the researcher. The researcher sat with the students while they completed the survey. This was to make sure they interpreted the questions as expected. Testing was carried out by peers of the researcher because they were experienced researchers who could provide specialist advice on structure, presentation etc.

Piloting of the survey helped to identify the following:

- Some wording was deemed confusing and difficult for the target audience to understand
- The average length of time the survey took to complete.

After the survey was pre-tested and changes were made, it was ready to be issued to schools. Phone calls and emails were issued to Career Guidance Counsellors and school



Principals asking them to participate in the research. Once verbal agreement was received, a package containing details of the research and Board of Management approval forms, were sent to Principals and Career Guidance Counsellors. The online survey was available to schools to complete over an eight week period, from April and May 2014, to accommodate schools at a very busy time due to Leaving Certificate exam preparation and midterm holidays. The contents of the survey are included in Appendix F.

### **3.4.3 Survey Response**

Three schools took part: an all-girls single-sex convent school, an all-boys single-sex college and one mixed comprehensive school. A total of 161 students responded to the survey. Out of this, 19 responses were discarded due to incomplete answers or for not accepting the terms and conditions. This resulted in 142 responses for analysis.

### **3.4.4 Survey Analysis**

The survey results were downloaded from the SurveyMonkey data collection tool and placed in a spreadsheet for analysis. Data cleansing took place where responses that contained personally identifiable information was anonymised. The quantitative question responses were loaded into the software package 'IBM SPSS Statistics 22' for statistical analysis. The open-ended questions were analysed using the computer aided qualitative data analysis software (CAQDAS) 'IBM SPSS Text Analytics for Survey 4'.

## **3.5 Interviews**

The literature review highlighted the fact that Career Guidance Counsellors are an important influencing factor on students with regard to their career choices. To explore this theme, a semi-structured interview checklist was designed to gather qualitative data from Career Guidance Counsellors about their current guidance practices and their opinions on Computer Science as a course of study. According to Miller and Crabtree (1992), semi structured interviews are open-ended but focused and guided events that are co-created by the interviewer and the interviewee. These types of interview give the researcher some flexibility to adapt the questions to the situation e.g. omit questions, change the ordering or to adapt to information initiated by the interviewee (Saunders et al., 2009).

### **3.5.1 Interview Execution**

Six interviews with Career Guidance Counsellors were conducted as part of this research. Participants were invited to attend a face-to-face interview at a time and location that was convenient for them. Three interviews took place face-to-face while two were conducted by phone, due to constraints on the part of the interviewee. The final interviewee chose to return written responses to the interview questions. Interviews took approximately 40 minutes.

The nature of the research was explained to each interviewee at the start of the interview. All participants were advised that they were not obliged to respond to any question they did not want to answer and could withdraw from the interview at any time. They were informed that interviews would be completely anonymous and were offered the opportunity to ask questions before and after the interview. Researcher contact details were also provided. In accordance with ethical procedures, an information sheet and informed consent form were provided to each participant. Each interviewee indicated that they accepted the terms listed in the informed consent form by signing the declaration. Permission was also received from each participant to allow the interview to be recorded using an audio device. Copies of the information sheet, informed consent form and interview questions can be found in Appendices.

### **3.5.2 Interview Analysis**

Each interview was transcribed verbatim from the audio recording and word processed. All transcripts were saved in individual files and the names were coded for anonymity. Each recording was encrypted and stored in a password protected folder on a secure laptop. These recordings will be destroyed on completion of the study in September 2014. Interview analysis began with the 'getting to know the data' stage. This involved reading and re-reading the transcripts and listening to the interviews repeatedly to become as familiar as possible with the data. The next step in the analysis was to identify the key themes and core concepts. Each transcribed file was imported into the computer aided qualitative data analysis software (CAQDAS) package 'IBM SPSS Text Analytics for Survey 4'. Open coding was then used to break down, compare, examine and categorise data. This resulted in concepts developing which are the "building blocks of theory" (Strauss and Corbin, 1998 p.101). Axial coding was then used to identify relationships and

connections in the dataset that emerged from open coding. The final step was to interpret the data by using the themes and relationships that emerged from coding.

### **3.6 Ethics Approval**

It is important that ethical concerns are considered at each stage of the research process. Ethical considerations are needed to ensure the safety and well-being of the participants. An application was submitted to the TCD School of Computer Science and Statistics (SCSS) Research Ethics Committee on the 13th March 2014 for ethics approval to carry out the research. Approval was received on the 25th March 2014 before the survey was distributed or interviews were carried out. The SCSS Ethics Committee required that: participants to be eighteen years or older; give informed consent to participating in the research; their participation was voluntary and they could opt out at any point; all questions were optional and all answers would be anonymous.

### **3.7 Lessons Learnt**

#### **3.7.1 Survey**

The survey research was aimed at students who were in sixth year of second level schooling since these students were in the process of making study/career choices. Although research approval was granted in March 2014, the schools were extremely busy from March to May with practical exams, language orals and the midterm and Easter breaks. This impacted negatively on the participation rates and there was much lower than expected participation in the survey. Initially, six schools agreed to participate, but due to the timing of the project, a number of schools found it difficult to allocate time for pupils to complete the questionnaire. The closing date for the survey was extended to accommodate as many schools as possible. Even with a number of reminder emails from the researcher, only three schools out of the initial six actually participated in the survey. Along with time constraints issues, a lack of computer facilities and/or opportunities to access the computer room were cited as reasons for not being involved.

#### **3.7.2 Interview**

It was difficult to arrange interview times with the Career Guidance Counsellors since they were all extremely busy during the school day. Four out of the six interviews took place

outside of school hours and one interview was continuously rescheduled and did not happen until June, which impacted on the interview analysis timelines.

One interview candidate chose to respond to the invitation to interview with written responses to the questions. A further request to discuss the questions in an interview format was declined. This did limit the value of the contribution as there was no opportunity for the researcher to query the interviewee and follow up on interesting points or leads.

The period from September to December would be the best time to collect data as it is a much quieter time in schools and participants would be more readily available.

### **3.8 Summary**

This chapter reviewed the different research methodologies available and identified the research philosophy most appropriate to the research, namely, pragmatism, using mixed methods that incorporated both qualitative and quantitative data collection. The strategies used for primary data collection were interviews and a survey and the research was carried out using a cross-sectional time horizon due to the time constraints of this particular research.

## CHAPTER 4 FINDINGS AND ANALYSIS

### 4.1 Introduction

This chapter reports the findings of the online survey of sixth year second level students and the semi-structured interviews with Career Guidance Counsellors based in Irish secondary schools. It presents an analysis of the qualitative and quantitative results.

### 4.2 Survey Findings

#### 4.2.1 Profile of Schools

Three schools took part in the survey and were based in counties Galway, Roscommon and Kildare. None were private/fee-paying though one school had been a fee-paying boarding school up until 2007. The majority of respondents (43%) attended an all-girls school while approximately one third (32%) were in an all-boys school. One quarter (25%) attended a co-educational school (Table 4.1).

Of the 142 respondents, 77 were female (54% of the total) while 65 were male (46%).

TABLE 4.1 - Profile of Schools Surveyed

School Gender	Student Numbers	School Type	Location	Fee Paying	Respondents	Percentage going on to Third Level
All Boys	500	Secondary	Galway	No	45	Approx 98%
All Girls	575	Secondary	Roscommon	No	62	Approx 95%
Mixed	700	Secondary	Kildare	No	35	Approx 80-90%

#### 4.2.2 Access to Technology

To understand what access respondents have to technology, survey participants were asked a number of questions such as the age at which they first used a computer and how proficient they were with technology.

The most common age for girls to first use a computer was eight years of age while for boys it was seven years of age and the full range was three years up to fifteen years of age. The results show that the boys were earlier users, with the majority of boys first using a computer between the ages of three and seven (Figure 4.1). For girls, it is slightly later with five years of age being the earliest a girl first used a computer. The most common ages for girls to first use a computer are between the ages of seven and ten.

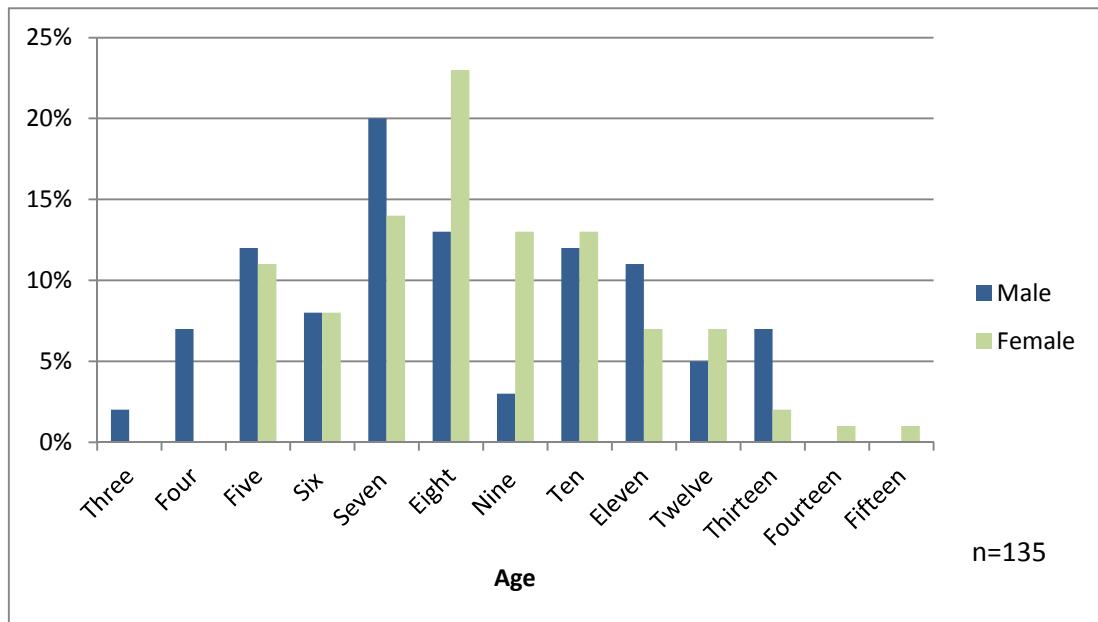


FIGURE 4.1 Age first used a Computer

Nearly all respondents (97%) stated that they owned smart devices: smart phones and/or tablets, indicating that students have embraced technology and access to the internet as a normal aspect of their lives. Overall, 92 per cent of respondents use social media sites such as Facebook or Twitter and only four female and seven male respondents said that they do not use social media.

Just over two-thirds (68%) of all respondents felt that they were 'Tech Savvy', (proficient in the use of technology) suggesting that confidence levels are reasonably high among the sample surveyed. Confidence levels did not vary too much between the male and female respondents with slightly more girls than boys reporting themselves as proficient in the use of technology (Figure 4.2).

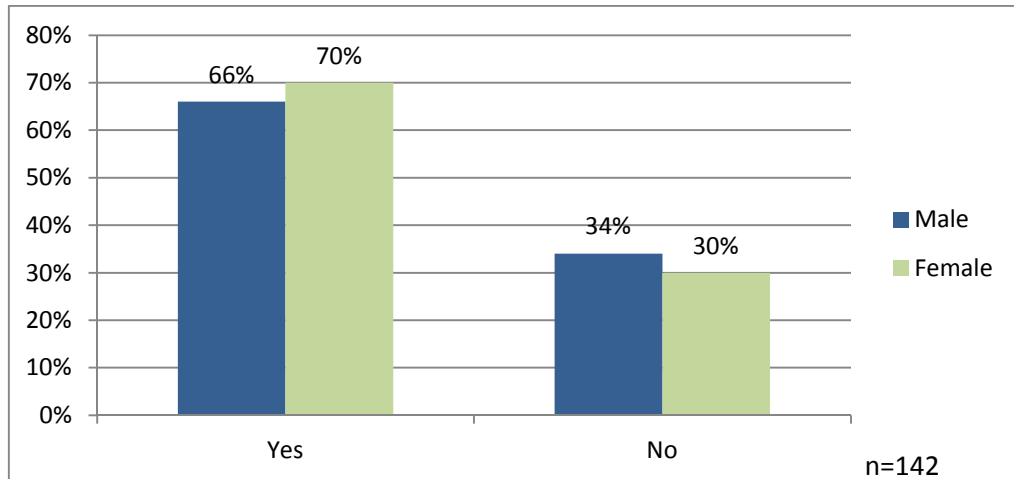


FIGURE 4.2 Proficiency in the use of IT

### 4.2.3 Perceptions of Computer Scientists

Respondents were asked to choose the characteristics that they would associate with people who have a career in Computing. Both male and female respondents rated being smart and knowledgeable most highly (109 and 96 mentions respectively). The stereotypical attributes such as geeky and nerdy also rated relatively highly but surprisingly, attributes such as anti-social, shy and unapproachable all scored comparatively low, especially by the female respondents. Being fun and cool also rated higher than expected with 41 and 40 mentions respectively (Figure 4.3). Previous research placed a strong emphasis on the geek or nerd factor as turning many young women off studying Computer Science. While it may still be a factor, being very smart is actually what more students' associate with a computing career.

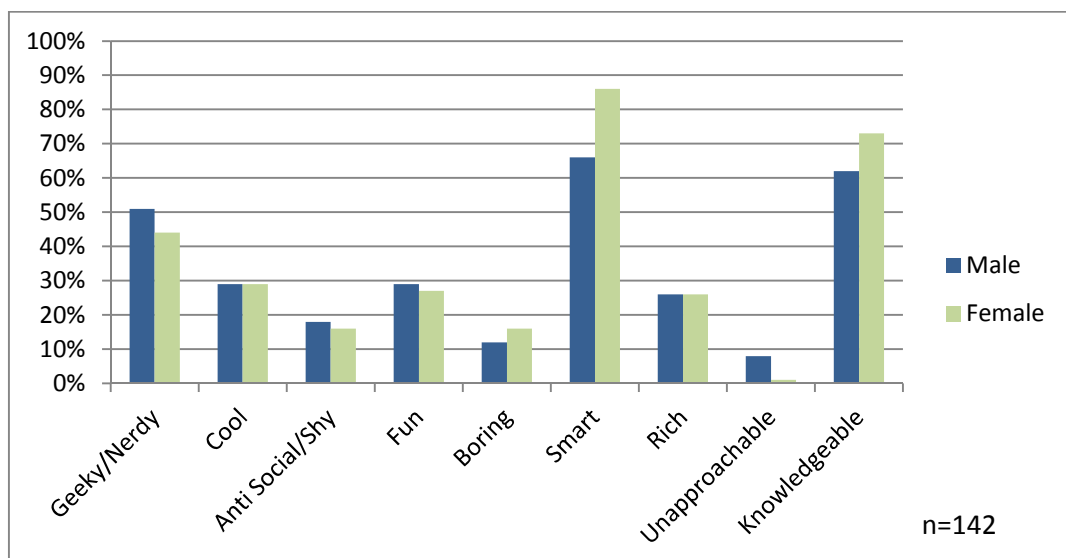


FIGURE 4.3 Characteristics linked with a Computing Career

When survey respondents were asked what they thought a person who works in the computing industry does all day, 50 per cent of female respondents did not know with comments such as ‘secretary’, ‘don’t know’, ‘sits at computer all day’, ‘I have no idea’, ‘Goes on the computer’, ‘Unsure’. While a small number of male respondents also did not know what working in the computing industry involved, the majority of them cited higher levels of awareness. Many male respondents referred to tasks such as ‘coding’, ‘programming in Java, Flash or C++’, ‘installing software’, ‘troubleshooting’, ‘web design’, ‘databases’, ‘fixing computers’, ‘maintaining corporate technology’ and ‘testing’.

Respondents were then asked to choose from a list the skills that somebody would need to work in Computing. The responses are contained in Figure 4.4. Both male and female respondents rated ‘logically minded’, ‘problem solver’, and ‘creative thinker’ as their top three most relevant skills. In contrast, skills such as being a ‘team player’, ‘good communication skills’, ‘business skills’ and being ‘outgoing’ rated low with both males and females.

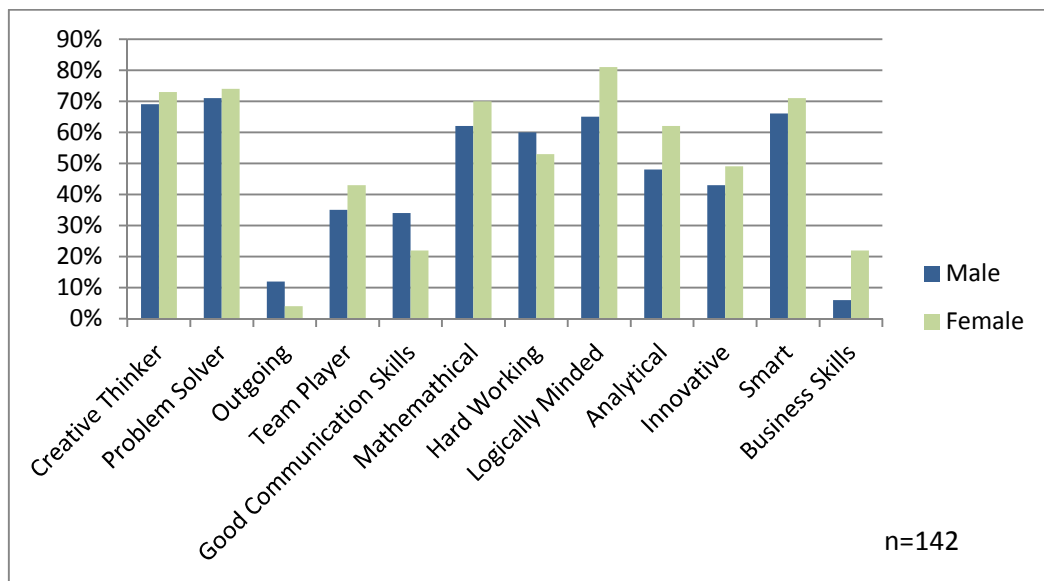


FIGURE 4.4 – Skills required to be a Computer Scientist

#### 4.2.4 Role Models

Nearly 89 per cent of respondents think role models are important (Figure 4.5). When asked, why this was the case, it is apparent that students are already aware of what a role model is and what their purpose would be in influencing their career choice. Recurring themes of: ‘aspire’, ‘encourage’, ‘inspire’, ‘influence’ ‘motivate’, ‘positive impact’ were mentioned by respondents.



A large number of respondents, particularly girls, commented on the fact that role models can inspire people to follow them in their chosen career path.

Some of the comments from female respondents were -

*'Good role-models who are happy with/promote their job encourage young people to consider that career'*

*'Encourages people to want to work in that profession and industry'*

*'To influence people into choosing it as a career'*

*'They help to motivate and inspire people to work in that certain area. They show off what is needed for that certain profession as well'*

*'They would encourage you to be more like them as they would leave a positive impact on you'*

*'So they can look up to them and encourage them'*

*'Because it's someone for you to look up to when making your own career choice'*

*'A positive role model will encourage a person to go far in the career'*

*'People look up to these people and it can encourage them to work hard and to achieve what they would like to do in the future'*

*'Positive role models encourage positive work and a positive outlook in the workplace'*

*'They inspire people'*

These comments highlight that girls particularly look for role models that will encourage and inspire them in their career area of choice.

Just over 40 per cent of survey participants know somebody working in the computing industry. When asked to specify who they knew it was mainly men who held these jobs: their uncle, brother or father.

Only four respondents referred to a woman working in the computing industry with the rest being non-gender specific: friends, relatives and neighbours.

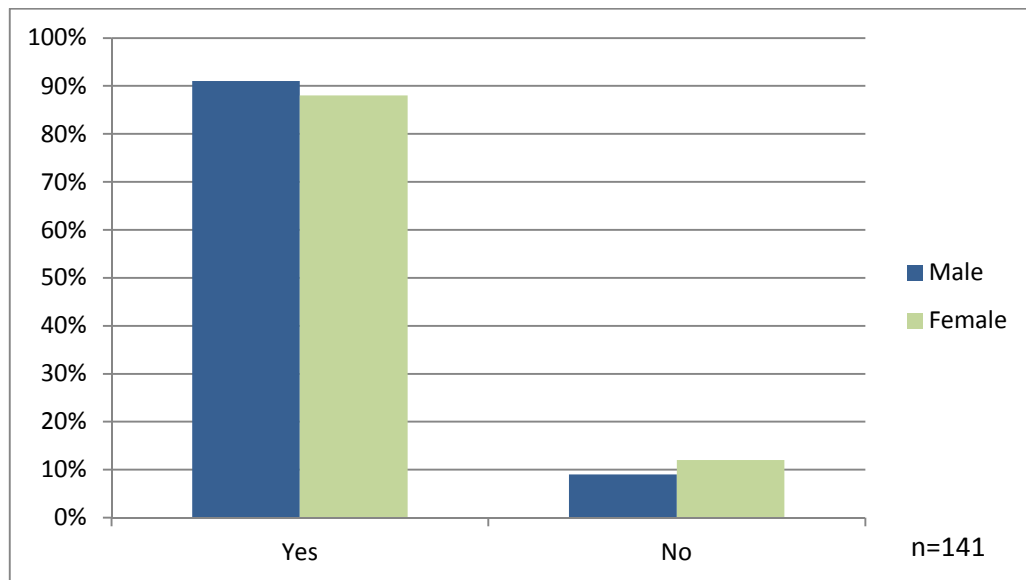


FIGURE 4.5 The Need for Positive Role Models

#### 4.2.5 Computer Games

Computer Gaming is one area that is perceived to be highly male-dominated and is associated with gender issues. Many games have themes of aggressive action which tends to attract boys and alienates girls (Greenfield, 1984). The mainstream games consoles for serious video game-playing are: Playstation and XBOX, while super PCs are also used by some serious gamers.

When asked if they play computer games, only 12 responded negatively: 2 boys and 10 girls. The PC/Laptop is the main device used, followed by Android and Apple iPhones. This indicates that gaming has evolved to become more accessible to a wider audience (Figure 4.6).

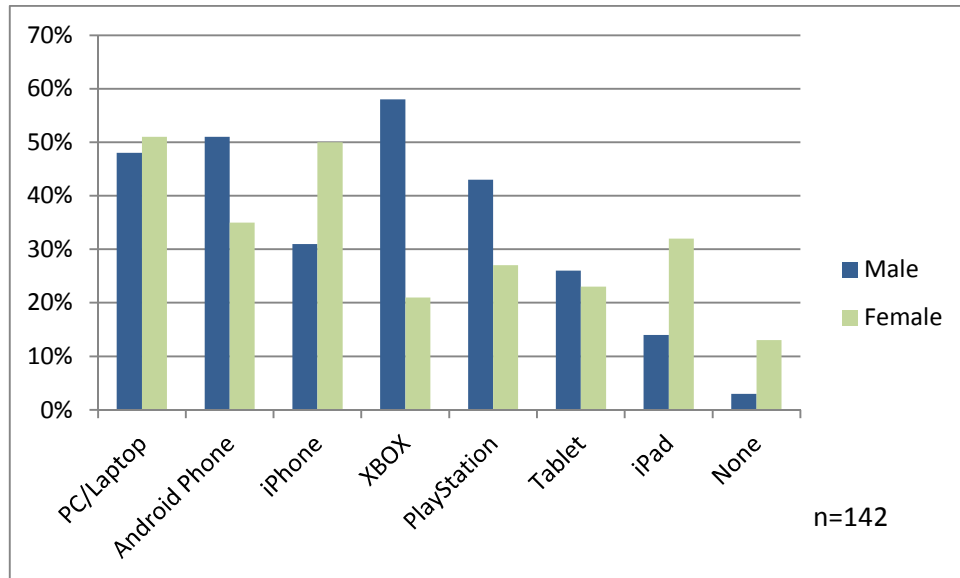


FIGURE 4.6 Devices Used to Play Games

Figures 4.7 and 4.8 display word clouds to highlight popular games played by boys and girls. The more popular the game, the more prominent it is displayed in the cloud. Games such as Grand Theft Auto, Call of Duty and FIFA, rate very highly with the boys. These games are all played on various consoles and are stereotypically marketed at males. In contrast, games such as Candy Crush, Flappy Bird, Temple Run and 2048 appear to be the most popular with the girls. These games are all smartphone games showing that gaming is growing increasingly more accessible via the social and smartphone route.

This highlights a major divide between the types of games boys play and girls play, with the boys listing stereotypical console games that incorporate themes such as sports, shooting, speeding, killing etc. Out of 51 male respondents, only 5 boys mentioned smartphone games. In stark contrast, it is the smartphone games that the majority of girls play, with 80 per cent of girls listing a smartphone game in their top three. These games are much more casual and normally have the main theme as puzzle-solving rather than the more graphic themes that mainstream video games offer. Out of 49 female respondents, 14 mentioned non-smartphone games such as Elder Scrolls, SIMS, Grand Theft Auto and Assassins' Creed.



FIGURE 4.7 Games Played by Boys

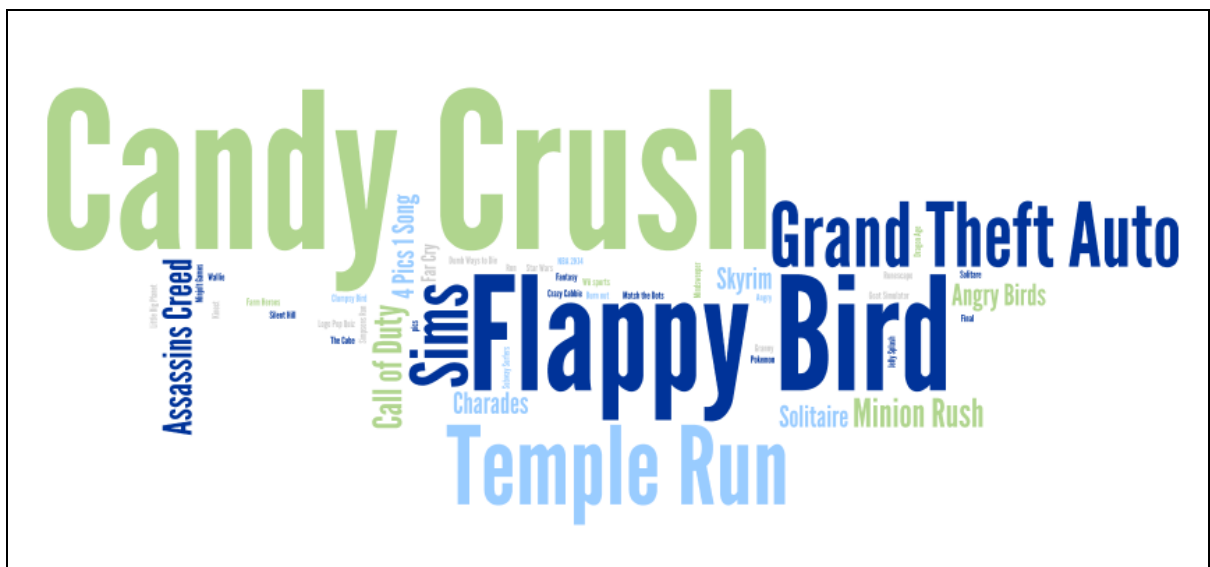


FIGURE 4.8 Games Played by Girls

#### 4.2.6 Third Level Education and Career Influences

Almost all respondents (97%) want to proceed to third level education, including 100 per cent of female respondents. The main reason for this is to enhance their career opportunities as students appear to be aware of the current economic climate and that a third level qualification a necessary requirement for getting a job they are interested in:

*'Because I think it is the best option if I want to get a good job that I love because there aren't many jobs in the current economic recession and you need qualifications to get most jobs'* (Female Respondent).

*'Logical decision in this economic climate'* (Male Respondent).

*'Because everyone goes to college now, there is no other option. There are no jobs out there or apprenticeships & I am too young to go travelling'* (Male Respondent).

*'Because a degree is important in today's society'* (Female Respondent).

*'To get a job in the future'* (Female Respondent).

*'It is the natural progression in order to get a good job'* (Male Respondent).

*'Because if you want to work in any area now, you have to have a third level education'* (Male Respondent).

*'Because you need an education to get a good job'* (Female Respondent).

*'Because it would be impossible to get a job otherwise'* (Male Respondent).

*'A brighter future with opportunities'* (Female Respondent).

*I want to be educated and get qualifications. It's easier to get a job with skills. I want to make new friendships with people who have the same interests as me.*  
(Female Respondent).

Participants were then asked who informs them and influences their career choices. Nearly three-quarters of the students (70% of the total) stated that their Career Guidance Counsellor was one of their main information sources. The internet was next with 42 respondents mentioning it as an information source. Parents, teachers, family and friends were the other main influences (Table 4.2).

TABLE 4.2 – Influences on Career Choices

Influence	Number of mentions
Career Guidance Counsellor	95
Internet (Career websites, Qualifax, Google)	42
Parent	21
Teachers	15
Family	18
Friends	12
University Perspective	7
People already in that Career	5
Past Students	1
Neighbour	1
TV	1
Private Career Guidance Counsellor	1

#### 4.2.7 Computer Science as a Career Choice

When asked if students had applied to study a Computer Science course, 13 per cent of participants responded positively: thirteen (21%) male respondents and five (7%) female respondents (Figure 4.9). Out of the five female respondents, only two mentioned a ‘love’ or ‘great interest’ in computers and technology. Two stated that they would like to have a Computer Science subject to be up to date, while another commented that she was persuaded to study it by her parents:

*‘I was convinced by my parents that this is the only area worth pursuing in terms of job aspects’* (Female Respondent).

Career influencers listed by the female participants who were interested in Computer Science were: *‘boyfriend’*, *‘friends’* and *‘using a computer at a young age’*. The remaining female participants mentioned influences such as *‘friends’*, *‘family’* *‘jobs’* and *‘future money/security’*.

The 13 male respondents who are hoping to study Computer Science were much more passionate than the female respondents, using words like *‘exciting’*, *‘interesting’*

*'enjoyment'*, and *'appealing'* to describe why they want to study the discipline at third level. These male respondents also appeared to be acutely aware of what is involved in a Computer Science course by mentioning aspects such as game development and programming. They also associate skills such as problem-solving and being good at Mathematics, suggesting an awareness of the skill set required to study Computer Science. The male respondents appeared to have had an interest at an early age and more experience with 'tinkering' with computers than the girls had:

*'I have always been good with computers. I always love messing around with command prompt, downloading new software etc. There are plenty of jobs in this area'* (Male Respondent).

*'I have a great interest in the whole idea of computer science'* (Male Respondent).

*'It appeals to me as I have good problem solving skills and am good at maths'* (Male Respondent).

For male respondents positive influences varied widely, from family and friends to good job prospects and the global economy.

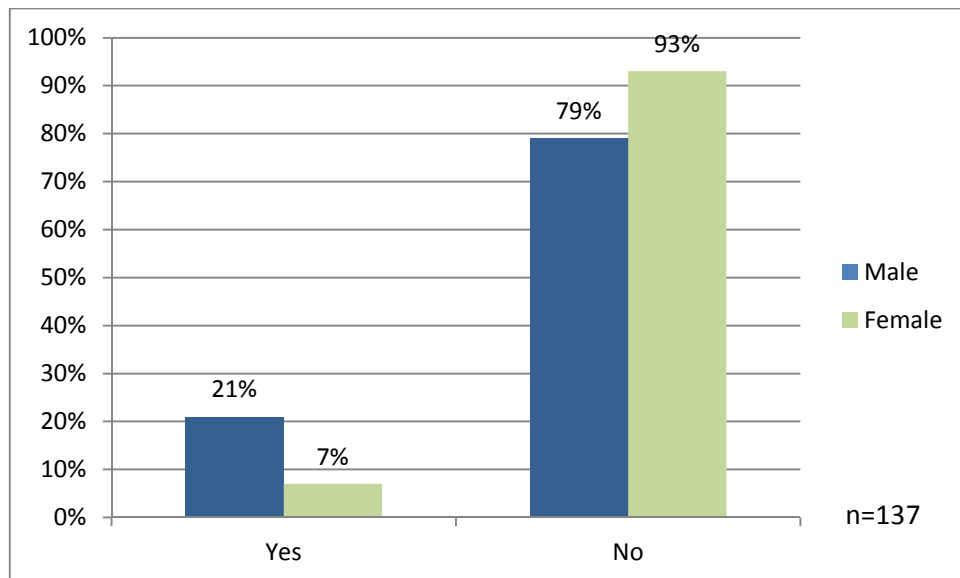


FIGURE 4.9 Respondents Planning to Study Computer Science

The majority of respondents (87%) are not planning to study Computer Science. Just over half of them cited *'no interest in computers'* in their open ended responses. Another common reason was their awareness that Computer Science is heavily related to

Mathematics: *'Maths is my weakest subject', 'I am an ordinary level Maths student', 'not strong enough in Maths', 'I don't like Maths' and 'I'm not mathematically gifted'* indicating that poor mathematical skills limit the number of both male and female students choosing to study Computer Science.

While male respondents cited lack of interest and a dislike for Mathematics as the main reasons for not choosing to study Computer Science, female respondents were more personally self-critical with comments such as: *'I'm stupid and not great with computers', 'I'm not an academic person. I don't have a good memory or mathematics skills', 'I don't think I'd be smart enough to complete a Computer Science course or even get enough points', 'I feel I wouldn't be smart enough to do the course and I wouldn't have much experience', 'I'm not very good with computers and technology in general', 'I am not the best at computers'*. These harsh comments are in contrast to their male counterparts, who were not self-deprecating. This highlights a major difference in confidence levels between girls and boys with regard to IT.

A number of female respondents also commented on the fact that they wanted to work in careers that involved working with, and helping, people. They felt that a career in Computer Science would not allow for this: *'I feel like I would be stuck in a job in front of the computer for the rest of my life', 'I prefer to work with people, not stuck indoors working on software by myself'*.

A number of male and female students felt they had very limited knowledge about Computer Science or the career options open to them as a graduate. Some stated that they have never heard of Computer Science while others felt there were no career opportunities with it upon leaving college:

*'I have never heard anything about this course. I would not know what this career involves or where does it bring you in the future. I would gather that there is not much after work involved'* (Female Respondent).

*'I don't know anything about this course and I haven't heard anything'* (Male Respondent).

*'Not enough detailed information of course content at second level to make a definitive choice. If there are so many job opportunities in this area, why is it not*



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*being introduced sooner? In comparison to legacy subjects, e.g metalwork, which is outdated and perhaps irrelevant'* (Male Respondent).

*'I didn't know much about it and preferred the business side of things'* (Female Respondent).

#### **4.2.8 Mathematics**

Strong mathematical skills are required to succeed in a third level Computer Science course. Higher level Mathematics is a pre-requisite to study Computer Science at some Irish third level institutions, while some institutions accept a minimum of a B3 in ordinary level Mathematics. In this study, only 27 per cent of respondents are studying higher level mathematics. A high proportion of all respondents (70%) are studying ordinary level Mathematics and 3 per cent are studying foundation level.

Figure 4.10 shows that 3 per cent of female students are studying foundation level Mathematics, 83 per cent are studying ordinary level Mathematics and only 14 per cent are studying higher level. Mathematics is deemed to be one of the harder subjects on the Leaving Certificate syllabus and it can be very time-consuming and because of this, many students choose not to study the subject at higher level. To overcome this, the Higher Education Institutions introduced a bonus scheme in 2012 by whereby a student can achieve an additional 25 points by taking the higher level Mathematics exam in the Leaving Certificate. With only 14 per cent of female students studying higher level, this scheme does not appear to have had any impact to date on the female respondents in this sample. This is in contrast to the national average where, over the last five years, an average of 45 per cent of students taking the higher level Mathematics paper were female. However, of those taking the higher level paper, male students are more likely to get a better grade. Over the last five years 68 per cent of students receiving an A1, 60 per cent receiving an A2, 57 per cent receiving a B1 and 51 per cent receiving a B2 were male (State Examinations Commission, 2013).

The male students in this study are more in line with the national average with 42 per cent studying higher level Mathematics.

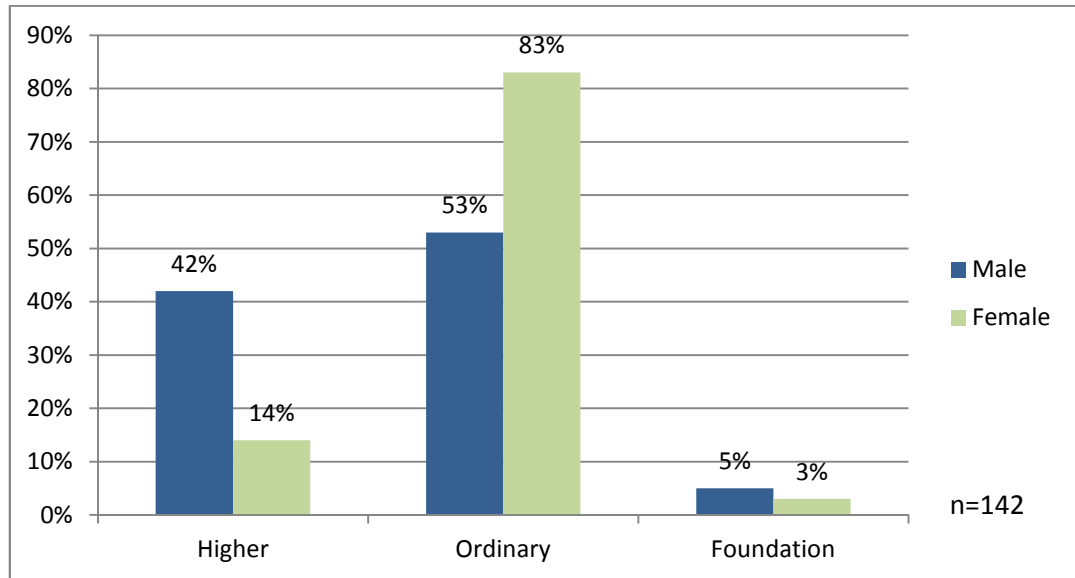


FIGURE 4.10 Level of Mathematics Studied

#### 4.2.9 Students Beliefs on why the Number of Students Studying Computer Science is Low

Survey respondents were presented with a statement telling them that the number of students choosing to study Computer Science at third level is very low. They were then asked to comment on why they thought this was the case. There were 132 responses to this question, 75 from female pupils and 56 from male pupils. A number of respondents, male and female, described Computer Science in negative terms such as: ‘boring’, ‘hard’, ‘difficult’ and ‘unappealing’, despite the fact that many students had said that they know very little about it and/or have no previous experience of Computer Science.

Nineteen female respondents and 3 male respondents described Computer Science as being difficult or hard: *‘It’s difficult and not liked’, ‘Many people think it would be too difficult’, ‘People think it’s very difficult’, ‘Very Difficult’, ‘Difficult’ ‘The courses might be hard’, ‘Too hard’, ‘It’s hard, not everyone understands everything to do with computers’, ‘I think people probably presume it’s a very hard subject to study’, ‘Because it’s hard’.*

Eight female respondents and 7 male respondents believed the course, or associated work, is boring: *‘They think it is boring’, ‘Because people may have the impression that it’s boring’, ‘Because it [is] boring’, ‘They might think it’s boring office work. They might want to be more active’, ‘People think it’s boring’.*

Sixteen (9 male and 7 female) respondents commented on the association between Mathematics and Computer Science as a reason why people do not choose to study it. The girls cited:

*'From my understanding there is Maths involved and they would find this unappealing'* (Female Respondent).

*'Possibly very Maths based, maybe a poor reflection on our current Maths programme'* (Female Respondent).

*'The points are high and often require higher level Maths, which is BEYOND Difficult'* (Female Respondent).

*'They think that Computer Science is Maths based and Maths isn't a nice subject for second level students'* (Female Respondent).

Male respondents concurred:

*'People think they need to be good in mathematics'* (Male Respondent).

*'Too much emphasis on Maths'* (Male Respondent).

*'One major, major problem is it's seen as being based on Maths. If people find Maths difficult they are immediately disinterested in Computer Science'* (Male Respondent).

*'It seems almost entirely Maths based, which many people do not engage with, as opposed to the creative and innovative side of the work'* (Male Respondent).

*'They see it as a complex mathematical problem solving course, one which some people can find too advanced for them. i.e. they don't feel smart enough'* (Male Respondent).

Another reason cited for not choosing to study Computer Science at third level is because they do not know enough about the course and the fact that it is not a subject at secondary level. The girls mentioned:

*'People may not be aware of what exactly computing is and what kind of opportunities Computer Science degree may provide'* (Female Respondent).

*'They may not know what the course entails'* (Female Respondent).

*'I don't really know much about the subject'* (Female Respondent).

*'Because I think people do not know much about it so they decide to stay away from it'* (Female Respondent).

*'There is not enough information available at the time of course selection'* (Female Respondent).

*'It is not a very well known career. When people come around to talk to us as a class you never hear them mention anything about computer technology'* (Female Respondent).

Some boys also noted:

*'It is not a subject choice in schools. Students do not know enough about it before college so they do not pick it'* (Male Respondent).

*'People don't know what's involved'* (Male Respondent).

*'People don't have much knowledge of the subject'* (Male Respondent).

Another interesting recurring theme for male respondents is that the CAO Points required to gain entry into Computer Science at third level are too high. Six male respondents referred to this, compared with only one female respondent: *'Large number of points'*, *'High CAO points'*, *'Because a lot of the courses require high points such as in the 400s'*, *'the points are very high'*, *'the points are too high'*.

Respondents were then asked what could be done to increase the number of students studying Computer Science. There were no major differences between the responses from male and female participants. The main feedback was that more information is needed on Computer Science courses. Many respondents felt that there was not enough

information on what Computer Science is or what is involved when studying it. Many also felt that more could be done to promote the courses and resulting career options. Another suggestion from respondents was to have people from industry and colleges to come in to give talks on the Computer Science courses. The female respondents expressed this:

*'Get people who do the career come in to have talks because there is very few that do and also get people to show them what the career is really like'* (Female Respondent).

*'It should be talked about more with students about it being a great option for students who enjoy working with technology. It is not talked about as much as other courses'* (Female Respondent).

*'Giving secondary school students more information about the career'* (Female Respondent).

*'Make the course more known and have more info. on the course. I personally have never heard of Computer Science'* (Female Respondent).

*'More information on it maybe. I don't really know anything about it'* (Female Respondent).

Male respondents also reinforced this:

*'Promote it more'* (Male Respondent).

*'Promote the fact that it's not all Maths that its more logical thinking. Show the types of jobs that can be gotten out of this area'* (Male Respondent).

*'Provide more information'* (Male Respondent).

*'Promote the courses'* (Male Respondent).

Some gender differences in the responses were evident. Male respondents referred to the CAO points being too high while some of the girls referred to the 'geek' stereotype or the bad culture often associated with Computer Science:

*'Make it more appealing and ditch the 'How can you not understand this?' attitude. People with these skills are very intelligent, talented and persistent people in what they are learning but they must be empathetic to actually bring in people who may not have a clue and that will keep them interested if they feel like you don't mind showing them and that it is possible to learn and that they will enjoy it. Who knows a lot of people might find a sudden interest in Computing'* (Female Respondent).

*'Promote it as a geek free zone'* (Female Respondent).

*'Not make it sound so intimidating'* (Female Respondent).

*'Lower points', 'Reduce the amount of points needed to enter these courses', 'Bring down the points', 'Lower the points'* (Male Respondents).

Twenty-two respondents (12 female and 10 male) felt that Computer Science classes should be taught in schools to inform students about the subject and what studying it would entail. Workshops were another suggestion made by a number of female pupils.

#### **4.2.10 Computer Science as a Second Level Subject**

Very few respondents (16%) stated that they had previous experience of studying Computer Science, half of whom were girls. The experience that many have is 'self taught' varying from learning how to use a computer, reading about programming to actual coding. Only two respondents (one male and one female) had attended Coder DoJo classes. Neither of these two respondents wanted to study Computer Science at third level.

Male respondents appear to have more relevant experience where their parents work in the industry and they have experience in coding and database development already.

*'My dad has shown me lots of stuff. He is a programmer so he has taught me how to program. We also have lego robots'* (Male Respondent).

*'I create database programs for my dads company which deals in computers'* (Male Respondent).

Of the IT experienced group, only 1 female has applied to study Computer Science at third level whereas 7 male respondents have applied.

As Figure 4.11 shows, 88 per cent of male and 82 per cent of female students agreed that Computer Science should be taught as a subject in second level schools.

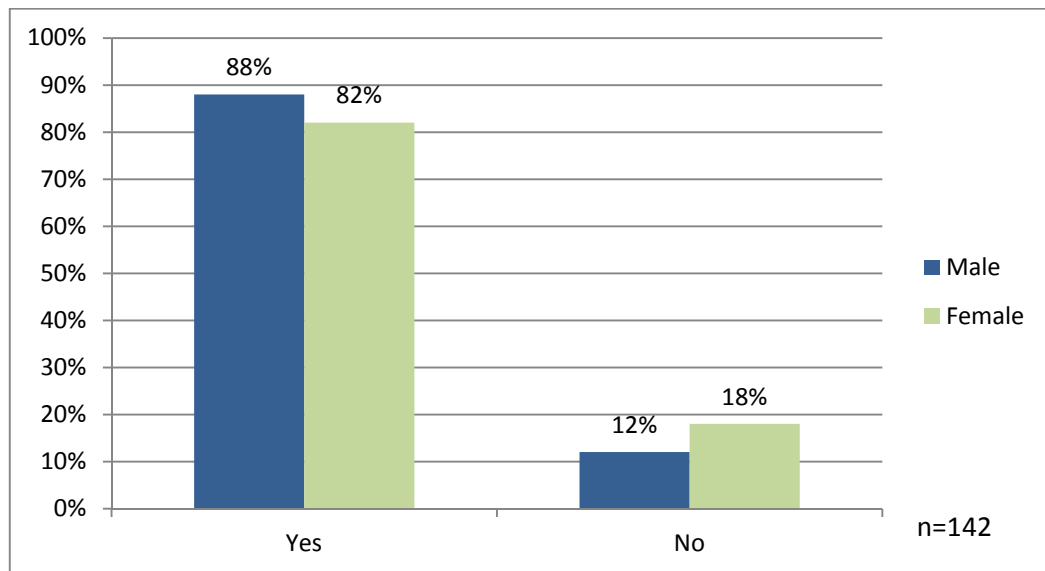


FIGURE 4.11 Computer Science as a Second Level Subject

When asked why they thought Computer Science should be taught in second level schools, many students demonstrated awareness that the computer industry is one of the largest growth sectors and that computers are very important in today's world. One of the key recurring themes was that a basic knowledge is needed regardless of what career path a person chooses. Students felt that an IT course would give them an understanding and awareness of the subject and ultimately give them skills that they could use in many different types of jobs. It was also acknowledged that an opportunity to study the subject at second level would give students an insight into what Computer Science was about and result in an increase in the number of students opting to study it at third level.

Twenty-two respondents (8 male and 14 female) said that they did not think Computer Science classes were a good idea in second level schools, claiming that it was such a specific subject and not everyone would be interested in it:

*'Maybe if it was an optional subject but not as a compulsory subject because not everyone would be interested in it'* (Female Respondent).

*'Many Students would be uninterested. Mandatory CPR lessons would be more useful'* (Male Respondent).

*'Because its an area that's not very popular which means maybe there isn't a huge interest in that area. So why should it be studied when a big number will not pursue it as a career as its such a specific area'* (Female Respondent).

*'Not everyone would have an interest in it'* (Female Respondent).

Some students also felt that the second level curriculum was already too full and that they already have too many subjects to study.

### **4.3 Interview Findings**

Interviews took place with six Career Guidance Counsellors (one teacher is split between two schools) from a variety of secondary schools to obtain their views on the under-representation of girls in third level Computer Science courses. The interviewees were based in an all-girls school, two all-boys and three mixed schools.

The Career Guidance Counsellors were asked specific questions about their schools and gender stereotypes with regard to subject choice. Information was sought on the Career Guidance offered in their schools and their opinions on Computer Science as a course of study. The interviews followed a semi-structured format so while the basic questions were the same for each interviewee, new questions and topics were raised during the course of the interviews.

#### **4.3.1 Profile of Schools**

This section sets out the profile of the schools where the Career Guidance Counsellors were based, according to school type, student population, the location of the school and the percentage of students that go onto third level education (Universities and Institute of Technologies). Four of the schools were Secondary schools, while two were Community schools and one was a Vocational school (Table 4.3).



TABLE 4.3 - Profile of Career Guidance Schools

School Gender	Teacher Gender	Student Numbers	School Type	Location	Percentage going on to Third Level
All Boys	Female	550	Secondary	Westmeath	Approx 90-95%
All Boys	Female	500	Secondary	Galway	Approx 98%
All Girls	Female	575	Secondary	Roscommon	Approx 95%
Mixed	Female	700	Secondary	Kildare	Approx 80-90%
Mixed	Female	1100	Community	Dublin	Approx 75%
Mixed	Male	160	Vocational	Longford	Approx 50%
Mixed	Male	150	Community	Longford	Approx 90%

#### 4.3.2 Gender Stereotyping of Subjects

Traditionally, subjects such as woodwork, metalwork and construction studies were stereotypically male-dominated subjects, while Home Economics was traditionally a female subject. This 'gender divide' still impacts on the subject choices that are offered schools.

In the all-girls school, the subjects offered were Mathematics, a variety of languages, Business and Science subjects, Art, Home Economics, and Music. There were no stereotypically male subjects available such as such as Engineering, Technology, Design and Communication Graphics, Woodwork, Construction Studies and Metal Work. Hence, girls who attend this school do not have the option to study these subjects, even if they wanted to.

Both of the all-boys schools and the co-educational schools offer a number of stereotypically male-dominated subjects and participation is high among the male students. However, the female students still appear to stay away from them.

When asked why they thought this was the case, a number of reasons were proposed: these subjects are stereotypically male-dominated hence girls are automatically not interested in them; practical work can also be physically demanding which could turn girls off. One interviewee felt that it is in the genetic make-up of boys who like the practicality of the subjects, using their hands, as opposed to taking pages of notes:

*'I think it's a combination of things. I think it's seen as a stereotypical subject [Engineering, Technical Graphics, Construction, Metal Work] that is more orientated towards boys than girls or they [girls] say they are not interested in them. Sometime girls don't have a strong spatial awareness. It's a combination of things. There is a certain bias towards subjects for girls and boys unfortunately still' (Mixed School).*

*'I find that some subjects are just more tailored for the boys, such as Metalwork, Construction, Engineering, Agricultural Science. It is in their genetics. They want to do these subjects and I find from speaking to the boys, these subjects interest them because they don't have to take pages of notes in class and they get to use their hands' (Mixed School).*

In one all-boys school, described by the interviewee as a technology focused school, they recently introduced Home Economics. This would be a stereotypically female-dominated subject and while some of the male students were interested in the subject, it was not a popular subject at Leaving Certificate level.

#### **4.3.3 Higher Level Mathematics**

Mathematics was a topic of relevance among Career Guidance Counsellors. In the two all-boys schools, the Career Guidance Counsellors felt that Mathematics was an important subject with 60-70 per cent of the students taking higher level for their Leaving Certificate. In the mixed schools, while the percentage of male students doing higher level was lower than in the single sex schools, uptake by male students was still significantly higher among female students. The number of girls taking higher level Mathematics in the all-girls school was also relatively low.

The general consensus among the counsellors interviewed was that boys are more confident and will take the risk, whereas girls are afraid of trying and failing. Girls tend to avoid subjects that they might not perform well in whereas boys will attempt them.

*'More boys than girls definitely doing higher-level maths. I think they are more ambitious and not afraid of failing. Boys are more tempted to give it a shot. Whereas girls are not as adventurous or as keen to try something that they don't think they are going to do well in'* (Mixed School).

An observation from one all-boys school was that male students tend to dislike subjects that involve learning large volumes of information or require long essay style answers. Higher level Mathematics to these students is much less time consuming and straightforward:

*'They dislike learning loads of volumes of information, and they don't like writing out three pages of an essay and they see honours maths then as an easier or less time consuming and they don't have to write so much out'* (All Boys School).

Another comment from an interviewee based in an all-boys school was that the school really concentrates on subjects such as Mathematics, Science and Design and Communications Graphics and that the male students appear to find Mathematics easy in the school due to the focus and methods used to teach these subjects:

*'One reason perhaps is that we have a really good maths department. Students feel that they find it easier with the way it is taught and a lot of students like the project maths, the new curriculum that is being introduced. I know from speaking to other schools they dislike project maths but I think it is working well in our school. I don't know the reason why so many are taking the higher maths. Maybe it is a boy thing. Maybe boys perform better with maths but definitely in our school they would be gearing towards maths, science and the tech drawing'* (All-Boys School).

One of the reasons cited for girls not taking higher level Mathematics is that they analyse their college requirements and decide, based on these, whether to study higher Mathematics or not. The Guidance Counsellor felt that girls do have the same ability for the subject, but choose to commit and dedicate the extra time to other subjects that they

feel they can do better in. The CAO points system creates and encourages a culture where students are choosing subjects to maximise points to ensure third level entry. Another guidance teacher corroborated this and noted that she often gets asked by the female students about the Mathematics requirement for courses and if they need Mathematics at all:

*'I definitely think boys do better at the higher-level maths. Now whether it is a thing that they genuinely do better and they have an aptitude for it or whether it is a thing that girls don't value maths and they choose to give it up because they can commit and dedicate that extra time to other subjects where they can feel that they can do better. That probably does have a part in it as well. For the girls that don't take the higher level maths that probably have the ability to do it they have just invested the time in their entry requirements for whatever the course they are going into' (Mixed School).*

#### **4.3.4 Computer Science**

When asked about whether students are aware of careers in computing, the overall consensus was that only some students are. In the two all-boys schools, the students seemed to be more aware of computing as a career. In these schools, the Career Guidance Counsellors appeared to be very knowledgeable on the subject and very active in promoting it. One teacher has already invited speakers in from different universities to talk about their Computer Science courses while the other teacher actively promotes it as one of the careers where there are a lot of job opportunities and travel opportunities.

In one of the mixed schools, the students are aware of it because they have a designated IT class in the junior cycle where they learn how to program software and design games. All of these schools have students going on to study Computer Science at third level. In the rest of the schools, there does not seem to be too much awareness and the Career Guidance Counsellors themselves do not appear to promote Computer Science extensively.

#### **4.3.5 Addressing the Under-representation of Women in Computer Science**

Interviewees were asked from their professional perspective whether anything could be done, to address the under-representation of women in IT. Some of the main ideas and

suggestions to emerge included: inviting speakers from colleges and universities to give talks on their courses and inviting past pupils who had studied Computer Science and gone on to work in the industry back to the school to talk to the students.

One interviewee felt that inviting women from the industry to talk to the students might work, as long as the speaker was approachable and somebody students could relate to. This method would introduce female students to a positive role model in the industry and showcase women working in IT and how they have built successful careers. This respondent also felt that the introduction of a mandatory basic IT course would be beneficial at second level.

Another respondent felt that more could be done by Career Guidance Counsellors to educate parents about Computer Science courses and the career opportunities after studying it. This Career Guidance Counsellor felt that because Computer Science is not taught in schools, parents tend not to know too much about the subject and do not discuss it with their children at home. Information evenings for parents are a possible avenue for that.

One experienced Career Guidance Counsellor felt that it could not be resolved by Guidance Counsellors alone but that it should be tackled in conjunction with the Mathematics and Science departments. Since Mathematics is such an important part of Computer Science, it is crucial that the Mathematics department make the higher level Mathematics course as attractive as possible and that female students are encouraged to take the examination at that level. This could then be built upon by the Guidance Counsellor through promoting the subject to students and inviting speakers into the schools to talk about college courses and careers.

One interviewee felt that students just do not know what Computer Science is, so they automatically dismiss it. Their idea was to invite guests in to hold workshops to show the students what Computer Science is all about.

#### **4.3.6 Additional Feedback**

A number of interviewees indicated that the time allocated to Career Guidance classes in schools was an issue and made it exceptionally hard to perform the role effectively. As part of the 2011 budget, the Irish Government decided to change the ex-quota status of

the role of the Guidance Counsellor in Second Level schools which means that counselling hours must come from the standard teaching allocation. This was introduced at the start of the 2012/2013 school year and, as a result of this decision, principals are now responsible for scheduling what they feel is an appropriate level of Guidance classes in their school, without impacting on other academic subjects. Ultimately this has resulted in fewer Career Guidance classes and reduced time for one-on-one counselling, as highlighted in a survey carried out by Millward Brown on behalf of the Association of Secondary Teachers of Ireland (ASTI) in 2013. The research showed that, as a result of the abolition of ex-quota Guidance Counselling provision in schools in September 2012, “seventy-eight per cent of schools have made changes to guidance counselling services as a result of this. Of particular concern is that 7 in ten schools have reduced the provision of one-to-one guidance counselling for students” (ASTI, 2013 p.50).

The research by Millward Brown is corroborated by some of the interviewees, one of whom indicated that class times were very short and they only hold one guidance class with each class group every week. This results in less time with the students and less time to cover any topic in detail. The interviewee also stated that ‘one-to-one’ counselling had been greatly reduced.

Another interviewee said that they have had to compensate for this change. The loss of hours has reduced guidance hours by approximately five hours per week in their school so they are putting in a lot more personal hours so minimise the impact on their students. This has resulted in the teacher spending their allocated hours with the students and then using their own personal time to complete the administrative work and to contact parents. Even with this extra effort, time is still very much reduced with each student and sometimes, group sessions need to take place instead of one-to-one meetings.

#### **4.4 Critical Analysis and Discussion of Interview Findings**

- Stereotyping of ‘male’ and ‘female’ subjects still appears to be the norm in Irish second level schools. Since there is a direct correlation between subject choice at second level and future education and career choice, low female take-up of technology subjects limits their development across a wide range of practical skills and restricts their educational and career options (Smyth and Darmody 2007).

- In schools where the Career Guidance Counsellor takes an interest in Computer Science, the students tend to be more aware of the subject. These schools see a number of students go on to study the subject at third level. The opposite is the case where the Guidance Counsellor is not passionate about the subject. Consequently, students appear less aware of the subject.
- Career Guidance Counsellors gave a number of suggestions to address the under-representation of women in IT. These include inviting IT guest speakers into the school, showcasing women role models from the industry, educating parents, introducing mandatory IT classes, holding workshops and involving the Mathematics and Science departments.
- The reduction of Guidance Counselling hours in Irish secondary schools has impacted greatly on the service provided to students. The survey shows that 70 per cent of students rely on their Career Guidance Counsellor for advice. However, due to the cutbacks, some students do not get the time dedicated to them to discuss their career options, colleges, review aptitude tests etc.

## **CHAPTER 5 CONCLUSIONS AND FURTHER WORK**

### **5.1 Introduction**

The aim of this research was to determine why female students do not choose to study Computer Science at third level in Ireland. This chapter looks at the conclusions of the research undertaken in this study and makes recommendations to address these. It describes the limitations of the research and assesses the need for further studies into this field of research.

### **5.2 Conclusions**

Despite increases in women's representation in careers such as Law and Medicine, their participation in computing careers is well below that of men. The literature review identified the potential reasons for this, however, no studies were identified that focused on women in Computer Science in Ireland and due to the extensive growth of the computing industry in Ireland in recent years, the issue of a gender imbalance in Irish based computing jobs is becoming an ever increasing concern.

The focus of this research was to build upon previous research to understand why women in Ireland are not choosing Computer Science as a subject to study at third level.

Throughout the literature on gender and Computer Science, there are widespread findings that suggest women are less confident than men in their technical abilities and have inaccurately low self-efficacy in stereotypically male dominated careers (Margolis and Fisher, 2003; Cohoon and Aspray, 2006; Beyer et al., 2003). Echoing these findings, this study also indicates that lack of confidence and poor self-efficacy are one of the main reasons why girls are not choosing to study Computer Science at third level in Ireland. Even though there was no difference in how proficient male and female students rated themselves, female students doubted themselves much more than male students with regard to their ability to study Computer Science. Female students who have lower levels of self confidence can underestimate their ability in a given field and will be hesitant to apply for these fields of study at third level (Cohoon and Aspray, 2006).

Many students in this study cite that they have no interest in Computer Science or that it is 'difficult' and 'boring', yet they also state that they have no experience of it. Computer Science is not offered as a subject option at second level in Ireland which has resulted in



a lack of awareness and knowledge regarding the subject for students. While, the Irish Government has invested in ICT in schools over the last number of years, the focus has been on teaching basic computer skills, such as word processing and using IT as an aid in other subjects. Policy makers have avoided introducing Computer Science or programming as a subject in the curriculum. Ultimately, this is impacting on the numbers of students choosing to study Computer Science at third level and on the Irish economy on a larger scale. The Irish education system, from primary level upwards, will be pivotal to producing a skilled workforce to meet the needs of the economy.

Both male and female students acknowledged that role models are important to them. Female students in particular feel that a good role model can positively impact on career choices and encourage them to go into that industry. Female students often make decisions relating to their careers by being able to see themselves in the role through having direct access to a woman already in that role. However, a recurring finding from the literature shows that there is a severe lack of positive female role models in Computer Science careers (Margolis and Fisher, 2003; Cahoon and Aspray, 2006). With a lack of positive female role models, the dearth of women in Computer Science is self-perpetuating. If female students do not see women in computing careers they are less likely to feel it is a possible career option for themselves as there is no indication that they could succeed in that career. Under such conditions, female students may self-select themselves towards careers in which they do observe women having successful careers.

Among the many reasons cited by researchers for the paucity of women in Computer Science, negative stereotypes and culture have been cited to explain why girls are not choosing to study Computer Science. The results from this study concur with the literature findings that the Computer Science stereotype is perceived to be somebody who is geeky and nerdy and somebody who is very smart and knowledgeable in the area of Computer Science. Students also felt that people who work in IT careers would not have good communication skills or have out-going personalities. While both male and female students adhere to this, female pupils rated these characteristics particularly highly. This perception can make Computer Science seem intimidating and off-putting. Findings from the various bodies of literature suggest that women have a desire to work in more people orientated careers and do not feel that a career in Computer Science can fulfil this. (Teague and Clarke, 1991; Eccles, 1994)

The Career Guidance Counsellor emerged as one of the strongest influence on the career choices of both male and female students in this study. This finding is similar to observations by Eccles (1994) and Gibson (2003). The Guidance Counsellor is in a position to influence a student's perception of career options through the experience, information and knowledge they provide. This is apparent in this study as Career Guidance Counsellors in the all-boys schools appear to be much more focused on the stereotypical male careers such as Engineering, Mathematics and Computer Science. In contrast, Career Guidance Counsellors in the mixed and all-girls schools, do not appear to be strong advocates of these careers and do not promote them as much as counsellors in the all-boys schools. One major consequence of this is that female students do not get the information they need to make informed choices on a range of Science, Technology, Engineering and Mathematics (STEM) careers and specifically Computer Science.

### **5.3 Recommendations**

The feedback from this research study has been combined with the evidence-based research and initiatives from Carnegie Mellon University and Harvey Mudd College to propose a list of potential interventions to reverse the trend and help us move towards parity in Computer Science.

#### **5.3.1 Secondary School Curriculum**

The Irish secondary school curriculum should be reviewed to make it more relevant to the current needs of the Irish economy. With so many real jobs available in the IT sector, this is where the focus needs to be for second level students. The lack of education in ICT from primary school age has a detrimental effect on the numbers choosing it as a career option. This is particularly affecting girls who tend to shy away from subject areas they know least about.

The introduction of Computer Science as a second level subject would create an awareness of the subject and would ensure that girls get an opportunity to try it out in a classroom situation where there is less risk involved. This should also improve confidence levels in female students and start to break-down the stereotype that is associated with people who study Computer Science.

### **5.3.2 Mentoring and Partnership Program**

Research shows that the negative stereotype of girls' suitability for male dominated careers is harmful. To help eliminate the stereotype, girls need to be exposed to Computer Science in real world situations from an early age.

Partnerships should be formed between third level institutions, industry and secondary schools to showcase that Computer Science is a great career option for both men and women.

A partnership/mentorship program would lead to:

- Increased exposure for both male and female students to female role models in Computer Science careers
- Opportunities for third level institutions to hold workshops that brings secondary school students to their campus for a day to experience what studying Computer Science at third level is really like.
- Options for students to complete Computer Science work experience with real technology companies.
- The possibility for third level institutions to hold summer school for secondary school teachers to enable them to teach programming that would be gender neutral.

### **5.3.3 Promotion of Computer Science**

Results from this research show that students are not receiving enough information regarding Computer Science and the resulting career opportunities. Results also show that Career Guidance Counsellors play a pivotal role in providing career information to students.

To ensure that students are receiving current information on third level Computer Science courses and the possible career opportunities, the Career Guidance Counsellor could be leveraged by third level institutions and industries to promote courses and jobs to students.

Career Counsellors could also hold information nights on Computer Science for parents of both male and female students to help educate them on the options available for their children.

Female representatives from third level institutes and industry, who are enthusiastic about their work, could also come out to schools to give talks/workshop to promote Computer Science. This would also encourage schools, particularly all-girls schools, to adapt a more gender neutral attitude to Computer Science.

#### **5.4 Generalisation of Findings**

Due to the nature of this study, it was not possible to gain access to a random sample of students across all secondary schools in Ireland. However, a variety of schools were selected across different regions using a convenience based sampling method and the responses of 142 pupils were analysed. While the results are not necessarily representative of all Irish students' opinions about Computer Science, the results can be considered indicative of a wider cohort of second level students

#### **5.5 Limitations of Research**

Due to time, resource and financial constraints, a number of limitations were encountered during this research.

A convenience sampling technique size was used to gather opinions from students in Irish second level schools which can be prone to bias and influence which is out of the control of the researcher (Saunders et al, 2009). Further studies should use a probability sampling method to ensure that results can be generalised to the entire population.

The study was also restricted to students who are currently studying for their Leaving Certificate in Ireland. Further studies could be expanded to include a wider student base and include students of different ages throughout second level schools.

Despite these limitations, the results further our understanding of why female students are not choosing to study Computer Science at Third Level in Ireland.

#### **5.6 Future Research Opportunities**

Information from students surveyed in this research suggests that lack of exposure to Computer Science is one of the main reasons why it is not being pursued as a career option, particularly by second level schoolgirls. Both students and Career Guidance

Counsellors support the introduction of a Computer Science course into the second level curriculum. A future research opportunity could be linked to a pilot of such a course to enable a longitudinal study to be conducted on the impact of this intervention. Classes could start in transition year of second level schooling, with a pilot group, and continue throughout the senior cycle. Interviews and analysis could be undertaken each year with the goal of estimating their impact on students' career choices upon leaving school.

Non-progression or dropout rates from Computer Science courses are one of the highest of all courses offered at third level institutes in Ireland. In the academic year 2007/08, the non-progression rate for Computer Science was 27 per cent and 26 per cent in the academic year 2010/11 (Higher Education Authority, 2014d). As this figure is inclusive of both males and females, research could be carried out to investigate if female students who enter third level to study Computer Science are progressing to graduation and if not, what are the barriers to this?

Furthermore, analysis of the 'leaky pipeline' phenomenon could be completed with a focus on women and Computer Science in Ireland. The leaky pipeline refers to the continuous loss of women as they progress through their career in STEM. The attrition of women from these jobs needs to be reviewed in tandem with promoting careers at grass roots level. It will be fruitless to encourage women into careers in Computer Science, if there is nothing done to support them once they are on the career ladder.

## **5.7 Summary**

The objective of this research was to understand the reasons why female second level students are not choosing to study Computer Science at third level institutions in Ireland.

From a practical perspective, this research has demonstrated that there are a number of barriers that are stopping female students choosing to study Computer Science at third level in Ireland such as poor self efficacy, curricula, a lack of role models and negative stereotypes/culture.

This study has also provided data and insight that will enable more informed policy making with a goal of reaching gender parity in Computer Science courses in third level institutes in Ireland.

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## APPENDICES

### APPENDIX A: Ethics Approval

	communication difficulties	
	Patients	No


**School of Computer Science and Statistics  
Research Ethical Application Form**

Details of the Research Project Proposal must be submitted as a separate document to include the following information:

1. Title of project
2. Purpose of project including academic rationale
3. Brief description of methods and measurements to be used
4. Participants - recruitment methods, number, age, gender, exclusion/inclusion criteria, including statistical justification for numbers of participants
5. Debriefing arrangements
6. A clear concise statement of the ethical considerations raised by the project and how you intend to deal with them
7. Cite any relevant legislation relevant to the project with the method of compliance e.g. Data Protection Act etc.

#### Part C

I confirm that the materials I have submitted provided a complete and accurate account of the research I propose to conduct in this context, including my assessment of the ethical ramifications.

Signed:  Date: 12/03/2014  
Lead Researcher/student in case of project work

*There is an obligation on the lead researcher to bring to the attention of the SCSS Research Ethics Committee any issues with ethical implications not clearly covered above.*

#### Part D

If external ethical approval has been received, please complete below.


External ethical approval has been received and no further ethical approval is required from the School's Research Ethical Committee. I have attached a copy of the external ethical approval for the School's Research Unit.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_  
Lead Researcher/student in case of project work

#### Part E

If the research is proposed by an undergraduate or postgraduate student, please have the below section completed.

I confirm, as an academic supervisor of this proposed research that the documents at hand are complete (i.e. each item on the submission checklist is accounted for) and are in a form that is adequate for review by the SCSS Research Ethics Committee

Signed:  Date: 13/3/2014  
Supervisor

Completed application forms together with supporting documentation should be submitted electronically to [research-ethics@scss.tcd.ie](mailto:research-ethics@scss.tcd.ie). Please use TCD e-mail addresses only. When your application has been reviewed and approved by the Ethics committee hardcopies with original signatures should be submitted to the School of Computer Science & Statistics, Room F37, O'Reilly Institute, Trinity College, Dublin 2.  
SCSS Research Ethics Application Form September 2011



## **APPENDIX B: Interview Information Sheet**

# **TRINITY COLLEGE DUBLIN**

## **INFORMATION SHEET FOR INTERVIEW PARTICIPANTS**

### **BACKGROUND OF RESEARCH**

This research seeks information on what Career Guidance Counsellors in secondary schools are currently doing to make students aware of Computer Science as an option for third level.

Your participation in this research will make a contribution to our understanding of the current situation and will help us identify what invested stakeholders need to do to attract more students into Computer Science and to address the under representation of women on these courses.

### **THE INTERVIEW PROCESS**

The following points should be noted about the interview:

- Your participation is voluntary and anonymous
- You have the right to withdraw from the interview at any time during the process without penalty
- You may refuse to answer a question without penalty
- The interview process should take approx 30 minutes
- In order to accurately record the answers to the interview questions I will ask for you permission to audio record the interview, However, if this is not agreeable with you, I will take written notes which you will be asked to initial and date on completion of the interview.

## **THE RESULTS**

Once the interviews have been completed, the answers will be analysed and interpreted. No source, individual or school will be identified in my findings. If you wish, you may receive an electronic copy of the research dissertation by contacting me at [doolanp@tcd.ie](mailto:doolanp@tcd.ie), after the 1<sup>st</sup> September 2014

## **OTHER INFORMATION**

- This information is being gathered for the completion of a dissertation as part of the M.Sc. in Management of Information Systems
- I have no conflict of interest to the research topic and with any of the participants.
- I am required by TCD to inform you that if, in the course of the interview, you inadvertently reveal illicit activities, I must report them to the appropriate authorities.

## **APPENDIX C: Interview Consent Form**

# **TRINITY COLLEGE DUBLIN**

## **INFORMATION CONSENT FORM FOR INTERVIEW PARTICIPANTS**

### **Background of Research:**

Ireland is in the midst of an Information Age and the Information Technology (IT) industry is thriving with the presence of top international IT companies such as Google, Microsoft, Intel, Facebook, Twitter and many more, that have set up their here. These companies create hundreds of jobs and opportunities here yet there are not enough third level graduates, with computing qualifications, to meet their demand for a highly skilled workforce. This is a major concern since IT companies can readily outsource jobs or relocate to other countries that have a more IT skilled workforce.

Despite the uptake of third level computing courses Higher Education Institutions need to attract more high calibre of school leavers and mature students into Computer Science. The computing industry currently offers some of the most stimulating, innovative and creative jobs available to graduates. It is a fast paced environment that presents some of the coolest and exciting opportunities to work, with cutting edge technologies such as Google glasses, self driving cars, wearable computers, etc. Google and Facebook are among the best companies to work for, yet they are struggling to entice young Irish people into the industry.

This study seeks information on what attracts students into Computer Science and equally, what are the factors that dissuade them from applying to study it at third level?

### **Methodology:**

This research will be based on interviews conducted with guidance counsellors from schools that provide Career Guidance to their students. The interviews will take

approximately 30 minutes to complete and will be recorded. Each question is optional and you can withdraw or refuse to answer a question at any stage. The analyzed and interpreted data will be completely anonymous and the identity of any participant or their school will not be recorded or revealed in any way.

### **Publication:**

These data will be used in the completion of a dissertation as part of a MSc in Management of Information Systems, Trinity College Dublin. Recordings will be transferred to a computer and kept in a password protected folder for the duration of the research project. Once the research is published, the data collected will be encrypted and stored on a DVD which will be held in Trinity College in the School of Computer Science & Statistics for a minimum of 10 years.

### **Declaration**

- I am 18 years or older and am competent to provide consent.
- I have read, or had read to me, a document providing information about this research and this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction and understand the description of the research that is being provided to me.
- I agree that my data is used for scientific purposes and I have no objection that my data is published in scientific publications in a way that does not reveal my identity.
- I understand that if I make illicit activities known, these will be reported to appropriate authorities.
- I understand that I may stop electronic recordings at any time, and that I may at any time, even subsequent to my participation have such recordings destroyed (except in situations such as above).
- I understand that, subject to the constraints above, no recordings will be replayed in any public forum or made available to any audience other than the current researchers/research team.

- 
- I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights.
  - I understand that I may refuse to answer any question and that I may withdraw at any time without penalty.
  - I understand that my participation is fully anonymous and that no personal details about me will be recorded.
  - I have received a copy of this agreement.

*Please tick box*

- I agree to the interview being audio recorded      **Yes**       **No**
  
- I agree to the use of anonymised quotes in publication      **Yes**       **No**

**PARTICIPANT'S NAME: (PRINTED)**

\_\_\_\_\_

**PARTICIPANT'S SIGNATURE:**

\_\_\_\_\_

**Date:** \_\_\_\_/\_\_\_\_/\_\_\_\_

**Statement of investigator's responsibility:** I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

**RESEARCHERS CONTACT DETAILS:**

Paula Doolan

Email: doolanp@tcd.ie

Phone: 087-9658895

**INVESTIGATOR'S SIGNATURE:**

---

**Date:** \_\_\_\_/\_\_\_\_/\_\_\_\_

## **APPENDIX D: Interview Questions**

### **Semi Structured Interviews Questions with Career Guidance Teachers**

1. What type of school do you teach in and approximately what percentage of your students progress to third level education? (If the school is co-Educational) What is the Gender mix of students that go on to third level?
2. In your experience, do you think that students feel that there are some subjects more suitable for boys than girls and vice versa? Can you give examples?
3. If so, can anything be done to change this?
4. Do you promote non traditional career paths for both male and female students? If so, how?
5. Are your students aware of careers in computing before speaking to you?
6. Do you think students have pre-conceived stereotypes of the type of people who work in the IT Industry?
7. Do you ever hold talks for your students specifically on Computing/IT?
8. If so, do you ever have past pupils, who now work in the IT industry, back to give a talk?
9. Do you think some aspects of Computing should be introduced into the secondary school curriculum?
10. What more could be done from a Career Guidance perspective to address the under-representation of women in IT?

## **APPENDIX E: Survey Information Sheet**

# **TRINITY COLLEGE DUBLIN**

## **INFORMATION SHEET FOR SURVEY PARTICIPANTS**

**URL** - [https://www.surveymonkey.com/s/Computing\\_3rdLevel](https://www.surveymonkey.com/s/Computing_3rdLevel)

**Researcher:** – Paula Doolan

**Contact Details:** – doolanp@tcd.ie

### **Background of Research:**

Ireland is in the midst of an Information Age and the Information Technology (IT) industry is thriving with the presence of top international IT companies such as Google, Microsoft, Intel, Facebook, Twitter and many more, that have set up their European Headquarters here. These companies create hundreds of jobs and opportunities here yet there are not enough third level graduates, with computing qualifications, to meet their demand for a highly skilled workforce. This is a major concern since IT companies can readily outsource jobs or relocate to other countries that have a more IT skilled workforce.

Despite the uptake of third level computing courses Higher Education Institutions need to attract more high calibre of school leavers and mature students into Computer Science. The computing industry currently offers some of the most stimulating, innovative and creative jobs available to graduates. It is a fast paced environment that presents some of the coolest and exciting opportunities to work, with cutting edge technologies such as Google glasses, self driving cars, wearable computers, etc. Google and Facebook are among the best companies to work for, yet they are struggling to entice young Irish people into the industry.

This study seeks information on what attracts students into Computer Science and equally, what are the factors that dissuade them from applying to study it at third level?



## **METHODOLOGY:**

This study is based on an online survey that should take no more than 15 minutes to complete. Each question is optional and you can exit the survey at any stage. The analyzed and interpreted data will be completely anonymous and the identity of any participant or their school will not be recorded or revealed in any way.

Participants who fill in this online survey may be asked to further participate in a focus group. Survey results will be transferred to a computer and kept in a password protected folder for the duration of the research project. Once the research is published, the data collected will be encrypted and stored on a DVD which will be held in Trinity College in the School of Computer Science & Statistics for a minimum of 10 years.

## **Publication:**

These data will be used in the completion of a dissertation as part of a MSc in Management of Information Systems, Trinity College Dublin.

## **Declaration**

- I am 18 years or older and am competent to provide consent.
- I have read, or had read to me, a document providing information about this research and this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction and understand the description of the research that is being provided to me.
- I agree that my data is used for scientific purposes and I have no objection that my data is published in scientific publications in a way that does not reveal my identity.
- I understand that if I make illicit activities known, these will be reported to appropriate authorities.
- I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights.
- I understand that I may refuse to answer any question and that I may withdraw at any time without penalty.

- I understand that my participation is fully anonymous and that no personal details about me will be recorded.
- As this research involves viewing materials via a computer monitor, I understand that if I or anyone in my family has a history of epilepsy then I am proceeding at my own risk.

## APPENDIX F: Survey Questions

RESEARCHER: – Paula Doolan

CONTACT DETAILS: – doolanp@tod.ie

### BACKGROUND OF RESEARCH:

Ireland is in the midst of an Information Age and the Information Technology (IT) industry is thriving with the presence of top international IT companies such as Google, Microsoft, Intel, Facebook, Twitter and many more, that have set up their European headquarters here. These companies create hundreds of jobs and opportunities here yet there are not enough third level graduates, with computing qualifications, to meet their demand for a highly skilled workforce. This is a major concern since IT companies can readily outsource jobs or relocate to other countries that have a more IT skilled workforce.

Despite the uptake of third level computing courses Higher Education Institutions need to attract more high calibre of school leavers and mature students into Computer Science. The computing industry currently offers some of the most stimulating, innovative and creative jobs available to graduates. It is a fast paced environment that presents some of the coolest and exciting opportunities to work, with cutting edge technologies such as Google glasses, self driving cars, wearable computers, etc. Google and Facebook are among the best companies to work for, yet they are struggling to entice young Irish people into the industry.

This study seeks information on what attracts students into Computer Science and equally, what are the factors that dissuade them from applying to study it at third level?

### METHODOLOGY:

This study is based on an online survey that should take no more than 15 minutes to complete. Each question is optional and you can exit the survey at any stage. The analyzed and interpreted data will be completely anonymous and the identity of any participant or their school will not be recorded or revealed in any way.

Participants who fill in this online survey may be asked to further participate in a focus group.

Survey results will be transferred to a computer and kept in a password protected folder for the duration of the research project. Once the research is published, the data collected will be encrypted and stored on a DVD which will be held in Trinity College in the School of Computer Science & Statistics for a minimum of 10 years.

### PUBLICATION:

The data will be used in the completion of a dissertation as part of a MSc in Management of Information Systems, Trinity College Dublin.

### DECLARATION:

- I am 18 years or older and am competent to provide consent.
- I have read, or had read to me, a document providing information about this research and this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction and understand the description of the research that is being provided to me.
- I agree that my data is used for scientific purposes and I have no objection that my data is published in scientific publications in a way that does not reveal my identity.
- I understand that if I make illicit activities known, these will be reported to appropriate authorities.
- I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights.
- I understand that I may refuse to answer any question and that I may withdraw at any time without penalty.
- I understand that my participation is fully anonymous and that no personal details about me will be recorded.
- Since this research involves viewing materials via a computer monitor, I understand that if I or anyone in my family

has a history of epilepsy then I am proceeding at my own risk.

• I understand that I cannot name any third parties in any open ended text field of the questionnaire. Any such replies will be made anonymous.

**\*Do you accept the above declaration and agree to participate in this survey?**

Yes

No

**Do you use social networking sites such as Facebook or Twitter?**

Yes

No

**Do you own a smart device (iPhone, Android phone, Blackberry, iPad etc)?**

Yes

No

**What age were you when you first used a computer?**

**Would you regard yourself as 'Tech Savvy' (Proficient in the use of technology)?**

Yes

No

**Do you play games on any of the following? (Select all that apply)**

XBOX

iPhone

PlayStation

Android Phone

PC/Laptop

Tablet

iPad

Other

None

If you do play games, please list your top 3 games

**Would you be interested in finding out how games such as FIFA and Grand Theft Auto or Apps such as Facebook and Twitter are made?**

Yes

No

**Would working for a Technology company like Microsoft, Google, Facebook etc. appeal to you?**

Yes  
 No

Why?

**In your opinion, which of the following characteristics would you associate with having a career in computing? (Please tick all that apply)**

Geeky/Nerdy  
 Cool  
 Anti Social/Shy  
 Fun  
 Boring  
 Smart  
 Rich  
 Unapproachable  
 Knowledgeable

**What do you think a person who works in Computing typically does on a daily basis?**

**Which of the following skills would somebody need to work in Computing? (Please tick all that apply)**

- Creative thinker
- Good communication skills
- Hard working
- Analytical
- Mathematical
- Smart
- Innovative
- Team player
- Business skills
- Problem solver
- Logically minded
- Outgoing

**Do you think positive role models are important in any industry, profession or job?**

Yes

No

Why do you think this?

**Do you know anyone that works in the Computing Industry?**

Yes

No

Can you provide details?

**The number of students choosing to study Computer Science at Third Level is very low. Why do you think this is?**

**What could be done to increase the number of students studying Computer Science at Third Level?**

**Who helps to inform you about your career options?**

**Are you planning to proceed to Third Level Education?**

Yes

No

Why have you made this decision?



**Have you applied to study a Computer course (Computer Science, Information Technology, Software Engineering etc.) at third level?**

- Yes
- No

**Why do you want to study Computer Science? (Please give as much information as possible)**

**Please list, in order of importance, the key influences that made you want to study Computer Science? e.g parent, friend etc (1 = most important to x = least important)**

**Why have you not considered studying Computer Science? (Please give as much information as possible)**

**What is the main area will you be studying (e.g Medicine, Law, Computing, Teaching etc)**

**Have you any previous experience with Computer Science? (Coder Dojo, Hour of Code, Self Taught etc)**

Yes

No

Please give details

**Do you think Computer Science should be taught as a subject in secondary school?**

Yes

No

**Why do you think Computer Science should be taught as a subject in Secondary school? Please provide as much information as possible.**

**Why do you think Computer Science should not be taught as a subject in Secondary school?**

**Please select the level of Maths you are studying?**

- Honours Level
- Ordinary Level
- Foundation Level

**Are you male or female?**

- Male
- Female

**What type of school do you attend?**

- All Girls
- All Boys
- Co-Educational

**Is there anything else that you would like to contribute on the topic of Computer Science?**