University of Strathclyde

Department of Computer and Information Sciences

A Mixed-methods Investigation of Factors that Influence Students to Study a Computer Science Major in Scotland and Saudi Arabia

Amnah Ali Alshahrani

A thesis presented in partial fulfilment of the requirements for the degree of **Doctor of Philosophy**

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Declaration of Originality

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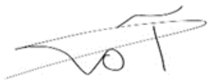
Signed: 

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Dedication

My beloved parents, for their encouragement and praying.

My beloved husband, for his advice, patience, and support.

My lovely three boys Yazied, Zeiad, and Bassam, for their patience.

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In the name of Allah, the most gracious and the most merciful

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Abstract

This thesis investigates the factors that influenced students to choose a Computer Science (CS) related major at university in both Scotland and Saudi Arabia. The research used Social Cognitive Career Theory (SCCT) to investigate the role of self-efficacy, prior experience, social support, and outcome expectation in influencing this choice. The research also investigated the influence of society's perceptions of a Computer Science degree. Scotland and Saudi Arabia are compared, as there is much greater gender balance in Saudi Arabia. The main contribution of the thesis is to identify factors which could help increase female participation in Computer Science, particularly in Scotland. The findings also have the potential to enhance the experience of all students prior to university. The research used an exploratory sequential mixed methods design, starting with semi-structured interviews (17 from Scotland, 11 from Saudi Arabia), followed by an online questionnaire to confirm and expand the initial results (192 responses from Scotland, 341 from Saudi Arabia). The research found that prior experience was not a major influence on student decisions, perhaps because the school curriculum is too focused on applications rather than on programming and problem solving. Encouragement from others seemed to play a major role, particularly for females in Scotland. Increasing the visibility of female role models has the potential to increase female participation. Self-efficacy seemed to be an important influence, derived from maths and problem-solving skills, prior use of technology in daily life, or an interest in creating and designing new things. The expected outcomes from a Computer Science major were found to be a very strong influence, with many students choosing Computer Science rather than their favourite school subject because of this. Society's perception of a Computer Science major, and those who study it,

could be an influence, particularly in Scotland if Computer Science is viewed as male-dominated.

Publication

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Chapter 1: Introduction

1.1 Introduction

The gender gap amongst students choosing to study certain subjects at university has received considerable attention in recent years. There are many efforts by governments and organizations in some countries to enhance and increase the number of females in Science, Technology, Engineering, and Mathematics (STEM) fields. The biggest gender imbalances are seen in the fields of computer science, engineering and technology, affecting a range of people from current students to graduates and workers (STEMWomen, 2019). In some Western countries, Computer Science in particular shows a gap that challenges governments, industry, and education. For example, since the American Association of University Women (AAUW)1 was established in 1881 it has generated many efforts to enhance and motivate females to pursue STEM subjects and help them to become engineers or scientists through programs, scholarships, and research. To promote the USA’s status as a world leader in science and mathematics education, the campaign "Educate to Innovate" was launched by President Barack Obama in 2009, one of the key goals of this campaign being "… expanding STEM education and career opportunities for underrepresented groups, including women and minorities” (Office-of-the-Press-Secretary, 2010). The UK’s Women in STEM

[1] https://www.aauw.org/, access date: 20/11/2020

Organization(2019) argued that, according to their “women in STEM” statistics, there is much to be done in STEM fields to reduce the gender gap, as shown in Figure 1.

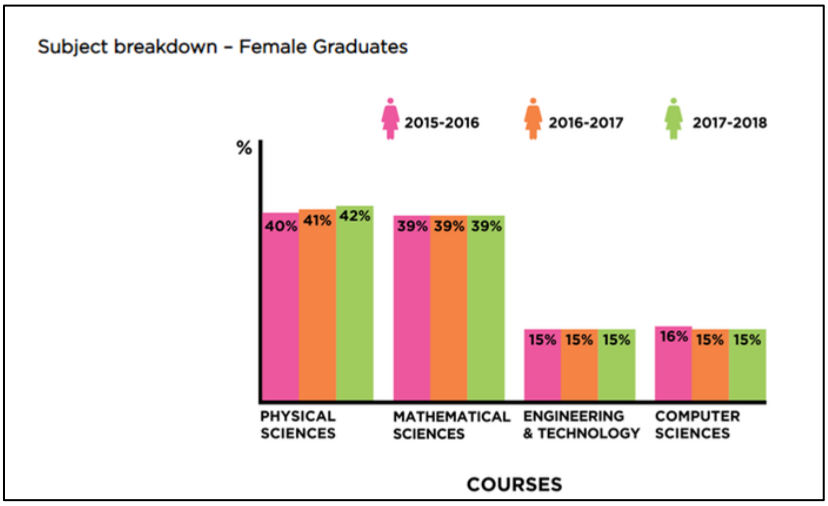

Figure 1-1 Females in Computer Science in UK, Source: stemwomen.co.uk

On the other hand, according to the Ministry of Education (2018), in Saudi Arabia the graduation percentages of students in some STEM fields are: in Computing 33% males and 67% females; in Natural Sciences and Mathematics 32% males and 68% females; and, in Engineering, 96% males and 4% females. The low percentage of females who graduated in Engineering might be because it is only in the last few years that Engineering departments in Saudi universities have started to accept females.

According to Computer-Science-org (2020), computer science research jobs will increase 19% by 2026 in USA. However, just 18% of Computer Science Bachelor's degrees in the United States are earned by females. Computer science remains a male-dominated field in the United States, notwithstanding the high job demand (Computer-Science-org, 2020). More than 80% of the job opportunities in STEM fields are offered in computing and engineering specifically (Landivar, 2013).

In contrast, in non-Western nations, some reports indicate higher numbers of females studying and working in the field of computing (Galpin, 2002). Examples of countries with a high percentage of female students in the Computing major include Myanmar with 60% and India with 42% (Powell & Chang, 2016). India and Malaysia are possibly the most documented examples of high percentage of women in computing (Vitores & Gil-Juárez, 2015). The computing field in India is seen as friendly, attractive and suitable for females (Varma, 2010a). In Malaysia, females are well represented, accounting for over half the students in computing related majors. Often, female students and lecturers dominate the computing fields in Malaysia (Mellström, 2009; Powell & Chang, 2016). Saudi Arabia shows broadly similar, and increasing, numbers of females studying computing with 45% around 10 years ago (OECD, 2012) and 67% around 5 years ago (MinistryofEducation, 2018).

In contrast, the percentage of female students graduating with a computing major in Western Countries is low (Sinclair & Kalvala, 2015). Catalyst (2020) argued that the gender gap in STEM in Europe is notably pronounced in the field of information and communication technologies. This can be clearly seen from the percentage of females graduating, where only 18% of the students who graduated with a computing major in the United States were female (Computer-Science-org, 2020), 19% in the United Kingdom (STEMWomen, 2019), 15.4% in France, and about 20% in Germany (Catalyst, 2020). With regards to Scotland, only 16% of students who graduated with a computing major were female (Graham, 2016).

Although the figures quoted above are from a range of sources and at a range of dates over the last decade or so, they show consistent low female representation in the West of 15-20% and much higher representation in Asian countries of 40-60%.

Moreover, Pappas et al. (2016) highlight the potential shortage in Europe: "The European Commission predicted that by 2020, in Europe, there will be a shortage of more than 800,000 professionals in the field of Computer Science". As a result of this huge increase in demand in technology fields, female representation in Computer Science is now a key factor for the economic and labour market (Beyer, 2014). However, in countries such as Scotland, females make up only 16% of students studying Computer Science at university (Graham, 2016). Despite all the efforts that have been made in some Western countries to encourage females to major in STEM fields, their representation is still low in some subjects, such as Computer Science.

1.2 Research Objective and Questions

This study investigates the factors that influence female and male students to choose to study a Computer Science major at university in two different contexts, Scotland and Saudi Arabia. Both males and females were included in this research to obtain a wider range of insights. The aim was to discover the factors that could encourage more females to study Computer Science, particularly in Scotland. The findings from this research will add to existing knowledge about female underrepresentation in Computer Science. Knowing the factors that have influenced students to study Computer Science could help policymakers to tackle this issue. Moreover, the research involves identifying the factors from the students' perspective in two different contexts.

It is important to discuss two different contexts, one which has female under-representation, and another that has high-representation. Scotland and Saudi Arabia were therefore selected as the two contexts to conduct the study. There are number of reasons behind this choice. The first reason is that the percentage of females who study a computing major in Saudi Arabia is much higher than in Scotland. Scotland and Saudi Arabia have participation rates that seem typical of lower and higher participation countries. The second reason is that Scotland and Saudi Arabia have different education systems. The third reason is that these two contexts are accessible for the researcher to conduct the research. Finally, both these contexts require more documented research on students' views of computing education, particularly Saudi Arabia.

Saudi Arabia has a gender balance in the Computer Science field and the differences and similarities between Saudi and Scotland may help to identify factors which could help increase female representation in Scotland. This study contributes to that effort by using Social Cognitive Career Theory (SCCT) (Lent, Brown, & Hackett, 1994) to try to identify and investigate the reasons that influence students, particularly female students, to choose to study Computer Science at university. The SCCT framework is focused on personal (e.g. gender), cognitive (e.g. self-efficacy), and contextual (e.g. social support) factors that are assumed to influence an individual's career/academic choice (Lent & Brown, 2006). SCCT focuses on students' prior experience, social support, self-efficacy, and outcome expectation. To address this objective, this study attempts to answer the following research questions:

RQ1: What is the role of prior experience in computing in influencing students to choose to study a Computer Science major?

RQ2: What is the role of social support in influencing students to choose to study a Computer Science major?

RQ3: What is the role of self-efficacy in influencing students to choose to study a Computer Science major?

RQ4: What is the role of outcome expectations in influencing students to choose to study a Computer Science major?

RQ5: What is the role of perceptions of Computer Science in influencing students to choose to study a Computer Science major?

1.3 Significance of the Research

This research makes three original contributions to knowledge. There are methodological contributions: an original research study design using SCCT as its basis, novel investigations in both Scotland and Saudi Arabia, and the finding that SCCT plus perception helps to identify some of the main factors which can influence females to study a Computer Science major.

There are also original contributions based on the main research findings: the limited impact of the Computing curriculum in influencing students, the influence of the optional nature of Computing at schools and the male-dominance in Scotland, the importance of encouragement from teachers, parents and friends, the importance of self-efficacy – confidence in abilities and skills, the potential influence of Computing career paths, and the importance of society's perception of Computing.

As well as these original research contributions there are numerous important suggestions made by participants that could help address these issues including: more programming and problem-solving in the pre-university curricula, making more Computing compulsory in Scotland, more visits to schools in Scotland by female role models, and more promotion of the Computer Science major in Scotland targeted at females. The contributions of this study will add knowledge to the literature on females in Computer Science. Also, the findings and the insights from Computer Science students could help policymakers design guidance on tackling the gender gap. For instance, the universities could develop strategies that could attract more females to Computer Science fields based on the findings in this study. Schools and families could be aware of their role in encouraging and supporting students to pursue Computer Science fields.

Female representation is important in the computing and engineering fields. Due to the increase in demand in technology fields, female representation in Computer Science is a key factor for the economic and labour market (Beyer, 2014). Corbett and Hill (2015) stated that female representation in computing fields would help encourage innovation and enhance gender equity. They have suggested that some companies may suffer the loss of a huge pool of potential talent and may not employ the best people for the job, which could lead to a lower level of global competitiveness for these companies (Corbett & Hill, 2015). Also, technical decisions will be derived from the views and the experience of males only when females are significantly underrepresented (Williams, 2014). Recently, there have been important efforts by scholars and researchers to investigate this issue, to understand the factors that cause it, and to determine how it might be addressed. Women's inclusion in STEM fields is important, as workforce diversity adds to creativity, productivity, innovation, and achievement (Blackburn, 2017). Also, Corbett and Hill (2015, p. 92) stated that “Women’s experiences – along with men’s experiences – should inform and guide the direction of engineering and technical innovation”.

This mixed methods study identifies the role of factors that influence Computer Science students to choose this major. Prior experience was not a major influence on student decisions to study a Computer Science major, perhaps because the school curriculum is too focused on applications rather than on programming and problem solving. Good background and interest at school in Maths, which is related to Computing, seem to play a role and may be a possible influence on students’ decision to major in Computer Science in both contexts. Female students’ underrepresentation in Computing classes at school is revealed by students in Scotland. An interest in Maths and experiences outside of school could have an influence, particularly for males in Scotland. Positive experiences for females in the early years at university seemed to be a supportive influence. Encouragement from others seemed to play a major role in influencing a student’s choice. Many of the students in this study, especially females in Scotland, identified a source of positive encouragement. It was also suggested that increasing the visibility of female role models had the potential to increase female participation. Self-efficacy seemed to be another important influence. Much of the self-efficacy in this study seemed to come from maths and problem-solving skills, prior use of technology in daily life, and an interest in creating and designing new things. An interest in computing also appeared to play an important role. Also, playing video games appears to motivate male students only. The expected outcome from obtaining a Computer Science major was found to be a very strong influence. Many students chose Computer Science rather than a major in their favourite school subject because of the career path offered by possession of a Computer Science degree. Students in Scotland identified the knowledge and skills acquired through a Computer Science degree, while Saudi students emphasized job opportunities. Finally, students' and society's perception of a Computer Science major and those who study it could be an influence, particularly if Computer Science is viewed as male dominated. Here there was a major difference between Scotland and Saudi Arabia, as in Saudi Computer Science is not male dominated. While the students recognized some of these negative perceptions, they themselves saw them as outdated.

There are a number of reasons why Computer Science might be perceived differently in Saudi Arabia. There appears to be a general view in Saudi Arabia that Computer Science is associated with good jobs. As Saudi Arabia has separate education for males and females there is no male dominance in Computing classes that is often found in Western countries. Finally, in Saudi Arabia females can see many female role models in the Computer Science field.

As previously mentioned about the countries that have high or low percentage of females in Computing fields, Saudi Arabia can be categorised as a country with a high percentage of females in Computing like Malaysia, while Scotland has a low percentage of females in Computing fields, typical of many Western countries.

1.4 Research Contexts

This section provides an overview of two research context: Saudi Arabia and Scotland. It will briefly cover some points within these two contexts which include background and the educational system. These points are discussed in the following sub-sections.

1.4.1 Saudi Arabia

Saudi Arabia is the largest Arab state in Western Asia by land area about 2,000,000 square kilometres (GAS, 2020). Saudi Arabia shares a land border with a group of countries. More specifically, it is bordered by Jordan and Iraq to the north, Kuwait to the northeast, Qatar, Bahrain, and the United Arab Emirates to the east, Oman to the southeast, and Yemen in the south. Moreover, there are two coasts which border this country, one from the east, the Arabian Gulf, and another from the west the Red Sea (GAS, 2020). The population of Saudi Arabia is 34.27 million (TheWorldBank, 2019). Saudi Arabia has many of the most significant historical Muslim sites such as Mecca and Medina (Gordon, 2005).

- **General Education**

Since 1932, Saudi Arabia has witnessed several developments in the educational sectors (Alfayez & Lambert, 2019). The government has applied a comprehensive plan on its educational system to meet the needs of the current age (Al-Ghamdi & Abduljawad, 2002).

The educational system in Saudi Arabia is divided into two stages: general and higher. In general education, there are three levels and includes elementary (six years), intermediate (three years), and secondary (three years) (Al-Ghamdi & Abduljawad, 2002; Alfayez & Lambert, 2019).

The secondary stage, however, is considered the crucial level for students and a bridge from general education to higher education (Alfayez & Lambert, 2019). Students in this stage receive a comprehensive and integrated preparation which provide them with skills and knowledge (Alfayez & Lambert, 2019). In this stage students can choose from two kind of systems: traditional and credit hours (Al-Ghamdi & Abduljawad, 2002). They learn various subjects which include Islamic, sciences (Chemistry, Physics, and Biology), maths, computing, language (Arabic, English), historic and physical exercises (PE).

- **Higher education**

As mentioned in the previous subsection students who have completed secondary school can pursue their education at universities. However, the acceptance of study at universities is based on grade point average (GPA) and national assessment tests (MOE, 2020).The national assessment tests are compulsory to apply for higher education.

In the last few years, the number of universities in Saudi Arabia has witnessed a great expansion, where the number has become 29 government universities and 35 private universities (MOE, 2020). Among these universities only six government universities and one private were established more than 50 years ago. The government universities include Umm Al-Qura University, Imam Muhammad ibn Saud Islamic University, King Saud University, Islamic University of Madinah, King Fahd University of

Petroleum and Minerals, and King Abdulaziz University, while the private university is Arab Open University (MOE, 2020).

According to Times Higher Education (2021), King Abdulaziz University is ranked amongst 201 to 250 of the best universities in the world, while Al Faisal University is amongst 251 to 300. King Saud University is located amongst 401 to 500, and King Fahd University of Petroleum and Minerals and King Khalid University is amongst 501 to 600 of the world's best universities. Among all of these universities, only King Saud University is in the top 200 universities in the world according to (UniRank, 2021).

1.4.2 Scotland

Scotland is the northern part of the United Kingdom and occupies about one third of the area of Great Britain. It has a number of great historical cities such as Edinburgh (Capital City), Glasgow, Dundee, Aberdeen, and Perth (Cameron, 2020). Scotland shares a land border with England from the south, the North Sea from the east, and the Atlantic Ocean from the west and north. With regards to topographic areas, Scotland as a country contains three main areas: the Highlands in the north, the Midland Valley, and the Southern Uplands (Cameron, 2020).

- **General Education**

The Scottish educational system is different when compared to the other nations in the United Kingdom. Scotland has its own qualification framework which follows its own curriculum. The educational system in England follows the national curriculum, while the Welsh education system uses the same curriculum except for the foundation phase

(TheSchoolRun, 2020). In Northern Ireland, the educational system follows their own curriculum. The educational system in Scotland follows the curriculum of excellence for nursery, primary, and secondary schools (TheSchoolRun, 2020).

In primary schools, students complete seven years, starting from P1 up to P7, P7 are transferred to secondary school to complete six years, starting from S1 up to S6 (TheSchoolRun, 2020).

The curriculum for excellence provides a wider and more flexible range of courses and subjects. The Scottish government sets guidelines about the curriculum which helps schools to make their own decisions about what to teach students. However, schools must teach three core subjects (health and wellbeing, literacy, and numeracy). Other than that, they have freedom to introduce one or more subjects which use skills and knowledge, such as Information and Communications Technology (ICT) (TheSchoolRun, 2020).

- **Higher Education**

In the 1960s, higher education in Scotland witnessed a huge expansion where it was transferred from "a unified system to a highly diversified one" (Gallacher, 2014, p. 96). This transition included five sectors. In the first sector, which represents the universities that existed prior to the 1960s, there are four “ancient” universities (Gallacher, 2006, 2009, 2014). They are the University of Edinburgh, the University of Aberdeen, the University of St Andrews, and the University of Glasgow. This sector receives about 30% of funded student places and 67% of the grants for research and innovation for 2020-21 (SFC, 2020).

The second group contains four universities which were formed or re-designed in the 1960s. These universities are Strathclyde, Heriot-Watt, Dundee, and Stirling. Heriot-Watt and Strathclyde were existing institutions of advanced technology, Dundee was one of the colleges of St Andrews University, while Stirling was a new establishment in that period. "These institutions have not, for the most part, achieved the level of international recognition achieved by the ancient universities. While they have 11 areas of research excellence, their overall weaker performance in this respect can be seen in that they currently receive only 23% of the Scottish Funding Council’s research funding" (Gallacher, 2014, p. 97). Nowadays, however they are considered as the major providers for postgraduate courses and research students in Scotland (Gallacher, 2014). Moreover, funded student places in 2020-2021 for this group is about 26%, and the grants for research and innovation is about 25% according to the Scottish Funding Council (SFC, 2020)

The third group contains the universities that were re-designed or founded after 1992, and they are called “Post 1992s” (Gallacher, 2006, 2009, 2014). According to Scottish Funding Council SFC (2020) and Gallacher (2014), seven universities are included in this group: the University of Abertay Dundee, the University of the Highlands and Islands, Queen Margaret University (Edinburgh), Edinburgh Napier University, Robert Gordon University, Glasgow Caledonian University, and the University of the West of Scotland. These universities provide an undergraduate and postgraduate education, even for part-time students (Gallacher, 2014). These universities receive 38% of funded student places and about 6.2% of the grants for research and innovation for 2020-21 Scottish Funding Council (SFC, 2020).

The final group focuses on specialist colleges of arts, agriculture, drama, and music such as the Glasgow School of Art, the Royal Conservatoire of Scotland, and Scotland's Rural College. They receive about 3% of funded student places and about 3% of the grants for research and innovation for 2020-21 (SFC, 2020). They provide full-time undergraduate and postgraduate education, while the Open University provides part-time degrees through distance learning (Gallacher, 2014). The Open University receives about 4% of funded student places and about 0.1% of the grants for research and innovation for 2020-21 (SFC, 2020).

1.5 Organization of the Thesis

The remainder of the thesis is organized into seven chapters as follows: Chapter 2, Literature Review, presents a review of the literature on the topic. The first section focuses on the theoretical background, namely Social Cognitive Career Theory (SCCT), which guides this study. The other sections are about the following factors: prior experience, social support, self-efficacy, outcome expectation, and perception. Chapter 3, Research Methodology, discusses the methodology and methods employed in the study. It describes the use of sequential exploratory mixed methods (qualitative followed by quantitative), the methods used to collect data for the qualitative phase of the study (semi-structured interviews) and then the quantitative phase (questionnaire). The data analysis technique used for the qualitative data was content analysis, while descriptive statistical analysis was used for the quantitative data. The chapter also discusses the procedures for testing the validity and reliability of both types of data.

Chapter 4 presents the qualitative findings and introduces the main themes and associated sub-themes that emerged from the data, while Chapter 5 shows the results from the quantitative phase.

Chapter 6 then discusses the results and major findings and results based on the two studies (qualitative and quantitative). In Chapter 7, the thesis concludes by presenting the contributions of the study as well as directions for future research. Finally, the Appendices contain further information related to all the procedures that are used for data collection and the data analysis processes used for both phases of the study.

Chapter 2: Literature Review

2.1 Introduction

The aim of this study is to investigate the factors that influenced students (males and females) to choose to study a Computer Science major at university. This investigation will be conducted in two different contexts, Scotland and Saudi Arabia. This chapter will therefore review the literature relevant to the theoretical basis for this study, as well as previous work that investigated the factors that influence students' choice of a major, in particular the Computer Science major.

In recent years there have been significant efforts by scholars and researchers to investigate the issue of the gender gap in computing fields, to understand the factors that cause it, and to determine how to tackle this issue. Numerous studies have discussed the factors that appear to make female students reluctant to study computer science fields at universities (e.g. Beyer, 2014; Bock, Taylor, Phillips, & Sun, 2013; Laosethakul & Leingpibul, 2010). As cited in Tzu-Ling (2019), several studies have generally demonstrated the gender gap in STEM fields from a social-cognitive perspective by using individual background characteristics such as race, learning experiences in primary and secondary education (e.g. curriculum), variables of expectations and family influences. Others have investigated the factors that influence school or college students' intention to pursue a Computer Science major (e.g. Chachashvili-Bolotin, Milner-Bolotin, & Lissitsa, 2016; Denner, Werner, O'Connor, & Glassman, 2014; Lehman, Sax, & Zimmerman, 2017a). This study has a different focus, in that it seeks the factors that influenced Computer Science students to choose this major in two different contexts. This chapter will review the theoretical background for this study, the Social Cognitive Career Theory (SCCT) which will be used as a theoretical lens, and the literature on potential factors that influence students to pursue a Computer Science major at university. The factors brought up in the literature search were identified and classified based on SCCT constructs, along with an additional ‘Perception’ factor.

2.2 Theoretical Background

There are several studies that use theory or integrated a number of theories to address their objectives. Theory is used to guide the research to study and investigate a new phenomenon. According to Leedy and Ormrod (2005) a theory is an organized set of concepts and principles designed to explain a specific phenomenon. Klette (2011) argued that theories are used in research for several reasons. They might be used to predict, explain, and guide actions and behaviour. They might also be used to provide a structured set of lenses for actions or behaviour that can be observed, studied, or analysed (Klette, 2011). They also provide a scientific approach from which to address a research problem (Klette, 2011). In addition, “… it is helpful to use theories to evaluate and transform the information to knowledge after collecting and analysing the data. Also, to predict the rational results of the action. Moreover, with a theory, the researchers will produce meaningful outcomes not just a collection of worthy observations” (Cohoon & Aspray, 2006).

Therefore, the current research uses Social Cognitive Career Theory (SCCT) to investigate the factors that influenced students (males and females) to choose to study a Computer Science major at university.

There are four models to study enrolment behaviour (Regan & DeWitt, 2015). The first model is the Theory of Reasoned Action (TRA) which is introduced by (Ajzen & Fishbein, 1970). This model is used to study the relationship between attitudes, subjective norms of the individuals and their intentions and behaviours. TRA provides a broad theoretical framework for predicting the behavioural intention of individuals, which are based on their attitude and subjective norms (Djatej, Chen, Eriksen, & Zhou, 2015).

The second model is Theory of Planned Behaviour (TPB) which is developed by (Ajzen, 1985). It is an extension of (TRA) and used to study the relationships between attitude, subjective norms, perceived behavioural control of the individuals and their intentions and behaviours. TRA and TPB are mainly used to predict the behavioural intentions of individuals. Moreover, there is a significant risk that might limit the use of these two models, and it is the confusion between attitudes and norms where attitudes can often be reframed as norms and vice versa (Ajzen & Fishbein, 1973).

The third model is Expectancy Value Model (EVM) (Eccles, 1983). This model is used to investigate the individual’s achievements that are related to their choice and performance (Lin, Ettekal, & Simpkins, 2016). However, according to Holmegaard, Ulriksen, and Madsen (2014) and Bøe, Henriksen, Lyons, and Schreiner (2011), it is risky to apply this model due to its complexity.

The fourth model is Social Cognitive Career Theory (SCCT) which has introduced by (Lent et al., 1994). This model is used to study how individuals can developed their academic and career interests, how they can choose their educational and career fields, and how they can achieve success in their academic and career lives. According to Lewis, Anderson, and Yasuhara (2016) SCCT is a helpful theoretical framework with which to illustrate individual differences between gender and diverse ethnic groups in career /academic choices and interests.

2.2.1 Social Cognitive Career Theory

Social Cognitive Career Theory (SCCT) was introduced by Lent and his colleagues (1994), and was derived from Social Cognitive Theory (SCT) (Bandura, 1986). SCT focuses on the interaction between person, environment and behaviour and how they influence one another (Bandura, 1986). With regards to the SCCT, it focuses on personal (e.g. gender), cognitive (e.g. self-efficacy) and contextual (e.g. social support) factors that can influence an individual's career/academic choice (Lent & Brown, 2006). SCCT contains three models: the interest model, the performance model, and the choice model. The interest model examines the development of academic and career interests, including the home, educational, recreational, and peer-related aspects and how they influence interest in a particular occupational field (Lent et al., 2005). The performance model can be used to help illustrate accomplishments related to chosen or adopted goals. Thus, it helps to explain the level of achievement attained by individuals and the degree of success in a specific task or career path, especially when there are obstacles (Lent et al., 2005). The third model is the academic choice process which consists of factors that influence academic choice behaviour.

Lent et al. (1994, p. 94) argued that “our model may help explain the academic paths that people select”. This model includes personal and environmental variables that might influence students to choose their majors. It has been proposed by Lent and his colleagues (1994) that the choice model attempts to describe a set of standard processes with various conditions. Based on the previous explanation about SCCT models and for the purpose of this study, the choice model will be used.

SCCT is a helpful theoretical framework with which to illustrate individual differences between gender and diverse ethnic groups in career /academic choices and interests (Lewis et al., 2016). Gender is a one of the SCCT elements that forms the focus of this research since the emphasis is on the participation of females in Computer Science. According to Kanny, Sax, and Riggers-Piehl (2014), the use of SCCT can help to examine the gender gap in STEM. This theory has been used as a primary theoretical framework for investigating the factors that contribute to the underrepresentation of women and racial-ethnic minorities in STEM fields (Fouad & Santana, 2017). There are some studies have applied it to study and investigate the issue of choosing STEM majors, such as, Engineering fields (Lent et al., 2005; Navarro, Flores, Lee, & Gonzalez, 2014), Computing (Lent, Lopez, Sheu, & Lopez Jr, 2011), and Biological Science (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010). Moreover, various studies have applied SCCT as a theoretical lens on career choice for Information Technology students (McKenzie, Coldwell-Neilson, & Palmer, 2017), for computer and other disciplines students (P. M. Alexander et al., 2011), and for nurse educator studies (Thungjaroenkul, Cummings, & Tate, 2016). SCCT also has been applied as a theoretical framework in studies of the interest and intentions of school students to choose a STEM major (Chachashvili-Bolotin et al., 2016; Fouad & Smith, 1996; García-Pérez, Inda-Caro, Fernández-García, & Torío-López, 2020; Garriott et al., 2014; Rodríguez, Inda, & Fernández, 2016).

> Yet, no model exists that adequately predicts or explains individuals' decision to pursue a particular major and how this process may look different for men and women. For these reasons, Social Cognitive Career Theory is especially useful because it lends itself to our specific interest in (a) college major choice as a career-related decision, and (b) the role of gender in this process (Kanny et al., 2014, p. 4).

It can be stated that SCCT needs more attention to its application in a range of research. Shoffner, Newsome, Barrio Minton, and Wachter Morris (2015) stated that the majority of published SCCT-based work has centred on populations of high school and college-age subjects. Furthermore, most researchers have mainly used the SCCT model in quantitative research methodology, so it could be important to also use a qualitative methodology to allow further description by the participants. This could contribute to expanding participation in STEM fields by providing significant additional information (Shoffner et al., 2015). More qualitative studies are needed to understand better and explore students' decision-making process in tertiary education (Archer et al., 2010; Bergerson, 2009). Moreover, there is an empirical study conducted by Sheu and Bordon (2017) to provide a review of selected research. In their study, they argued that "the majority of studies tested hypotheses of the interest/choice and satisfaction models among adolescents and college students in

Asian and European countries" (p. 70). Sheu and Bordon (2017) argued that the SCCT needs more attention and implementation, especially in different contexts. Based on the previous explanation, it can be confirmed that more attention must be paid to conduct more exploratory research to investigate new related phenomena.

Positive high school experiences, math and physics abilities, expectation of a good wage, motivations of family members, and the influence of a key person such as a teacher, were factors that influenced students who chose Information Technology fields (McInerney, DiDonato, Giagnacova, & O'Donnell, 2006). However, there were some issues that cause women's absence in Information Technology fields such as lack of knowledge, beliefs, expectations, abilities, self-efficacy, perceptions, and sense of belonging because of the stereotype of Computing as a male subject (Vainionpää, Iivari, Kinnula, & Zeng, 2020). By reviewing SCCT, it acknowledges the role of gender, prior experience, self-efficacy, contextual support, and outcome expectations, as factors that influence career/academic decisions. Therefore, this study attempts to apply SCCT to investigate the factors that influence students' choice of a Computer Science major at university. These factors will be discussed in more detail in the following sub-sections.

2.2.2 Prior Experience

Prior experience refers to any previous experience in computing disciplines that students had before choosing to study a Computer Science major at university. According to SCCT, prior experience could influence the academic choice, so it is important to explore students' experience with the Computing curriculum at school as well as external activities such as online courses. The prior experience might incorporate experience in STEM subjects in general, particularly a Maths subject, as some previous studies have highlighted this point.

A significant relationship exists between the Maths subject at school and the STEM major that is pursued at university. There is a positive association between achievement in maths in high school and the interest in pursuing STEM majors in higher education (X. Wang, 2013). Fouad and Santana (2017) noted that an early intervention in middle and high schools, to prepare students to pursue STEM subjects in college or as a career, could consist of encouraging achievement in Maths classes. Also, developing skills during high school is important, as the next crucial juncture is college, where big decisions are made to join the STEM field (Fouad & Santana, 2017). Students' experience in Maths and their achievements in it may lead them to major in CS. Most of the participants in the Varma (2009) study believed that they were somewhat prepared for studying computer science because of taking Maths courses at school. Moreover, Hewner and Mishra (2016) found that there was a relationship between the interest in Maths and the choice to study Computer Science at university. On the relationship of the discipline of Computer Science to Maths, Bruce, Drysdale, Kelemen, and Tucker (2003) argued that the appropriate type of mathematics is crucial to the understanding and practice of computer science and can be useful in software development stages. Also, exposure to challenging Maths classes will assist computer science students in their ability to solve problems more creatively (Bruce et al., 2003).

As cited in Lee (2015), many studies concluded that the learning environments associated with science and maths influence a student's STEM major choice.

According to a study by Blackburn (2017) which reviewed the literature from 2007 to 2017 about the status of women in STEM higher education, several studies reported that exposure to STEM fields during high school through exploratory science and mathematics courses can have a positive impact on females, leading them to decide on a STEM major. Similarly, attending a STEM-focused school can reinforce interest in science and maths careers (Blackburn, 2017). Legewie and DiPrete (2014) found that the intensive Maths and Science curriculum in high school reduced the gender gap in science orientation and was associated with high school females' intentions to major in STEM fields.

So, the significance of studying science subjects, such as Maths, and their effect on students' choice of a STEM major at university, seems to be apparent in previous studies. In regard to the Computing subject specifically, the literature encompasses the relationship between learning a Computing subject, or any prior experience in it, and the choice of a Computer Science major at university.

Prior experience in the Computer Science field may influence the students' choice, particularly that of females. Taylor and Mounfield (1994) indicated that there was a significant relationship between female success in computer science college and prior experiences in Computer Science. Supporting this, a study by Beyer (2014) found that prior experience is a significant factor influencing participation of females in computer courses. One of the most important factors influencing the interest of females in computer science was early academic exposure to computer science (Google, May 2014). Furthermore, in a survey taken three years after high school, Weston, Dubow, and Kaminsky (2019) found that the best predictors of persistence in both Computer

Science and other technology-related majors were programming during high school and taking the Computer Science Advanced Placement[2] exam. Their results suggest and support the idea that encouraging girls to participate in more technical aspects of computing, and supporting them while they do so, can be an important pathway to the pursuit of computing majors. Also, efforts to increase participation in computing should highlight education in computer programming (Weston et al., 2019). Recognizing that females often have less experience in a Computing subject as reported in some studies, He and Freeman (2010) conclude: “results suggest that females feel less confident with computers because they have learned less and practised less”. In a study conducted by Buzzetto-More, Ukoha, and Rustagi (2010), Computer Science students indicated that they did not come to college with sufficient programming skills and previous experience to succeed as a Computer Science major. Also, it was found that females were less prepared than males. In a study exploring young women’s experiences at middle and high school and their perceptions of Computer Science, most participants did not know what a computer scientist did, and what activities they would engage in if they became computer scientists. Thus, females' lack of experience and knowledge contributed to lack of participation in Computer Science among females (Hur, Andrzejewski, & Marghitu, 2017). Denner, Werner, and O’Connor (2015) confirmed that three widely held beliefs, support from others, motivation, and prior experience, play a vital role in the intention of females to pursue Computer Science.

[2] “Advanced Placement (AP) exams are administered by the American College Board in the US for high school students”; source: Ontario universities

Even if a Computing subject is offered at school, the computing curriculum and the learning environment could play a role in influencing students, particularly females, to pursue or not pursue a Computer Science major at university. Regarding the learning environment, some studies have revealed that one of the reasons that affect students' decision not to take Computing subjects in high schools is their perception of Computing classrooms as boring (Anderson, Lankshear, Timms, & Courtney, 2008; Biggers, Brauer, & Yilmaz, 2008; Gal-Ezer, Shahak, & Zur, 2009). Also, the Computing classroom could be male-dominated, and this may hinder females from choosing the subject if it is not compulsory at high school. As cited in Master, Cheryan, Moscatelli, and Meltzoff (2017), the gender gap in STEM college participation decreased in countries and states that required both males and females to take more STEM coursework. Sapna Cheryan, Ziegler, Montoya, and Jiang (2016) asserted that there is a gender gap in some science subjects at high schools, such as Computing and Physics, but not in other subjects like Biology and Chemistry. However, in some countries, males and females are taught separately, either in separate classes or schools, and this could be a part of the learning environment which affects the students and their choices. Single-gender education (or separate education) could lead to engaging females in learning Computing subjects in a female environment rather than in male-dominated classes. Following the all-female approach led to rising student enrolment by 40% in one year in an elective Grade 11 Computing course (Crombie, Abarbanel, & Trinneer, 2002). Also, Crombie et al. (2002) found that females in all-female Computing classes reported higher levels of observed support from the teacher, confidence, and potential academic and employment plans than women in mixed-gender classes. If Information Technology classes are male-dominated, that could make the subject unattractive for females (Gürer & Camp, 2002). In addition, some studies reported that single-gender Information Technology classes provide female students with more relaxing and pleasant learning environments (Craig, 2005; Leech, 2007; Papastergiou, 2008).

Regarding the curriculum, discouraging females from majoring in Computer Science might be a consequence of poor pedagogical practices (Larsen & Stubbs, 2005). Aljughaiman and Ayoub (2012, p. 168) view on the curricula and practical skills was that "the current curricular content delivered in the majority of the schools is focused on traditional areas of academic achievement, and hence does not emphasize improving practical intelligence". Increasing student enrolment in upper secondary school science and technology courses could be done through pedagogical practices and practical tasks (Juuti & Lavonen, 2016). This study suggests that mandatory Computer Science classes show a significant pedagogical lag in comparison with other STEM subjects (Physics, Maths, Biology, Chemistry) which are persistently taught at a much higher and fairly standard level than Computing classes. This may illustrate why ICT related fields are unattractive to female students compared with other STEM fields. The authors believe that the experience in the classroom is causing low interest in ICT, particularly among females. They conclude that the need for a systematic upgrade of essential Computing classes is significant, as well as keeping up with ICT developments, since the experience in the classroom is a key factor in influencing career choices among young females (Kindsiko, Aidla, Poltimäe, & Türk, 2020). Carter (2006) found a lack of education in Computer Science at school and that only a few of the students in her investigation had studied something other than computer applications. The school curriculum in several countries seems to focus on applications such as Microsoft Office (Passey, 2017). Varma (2009) and Buzzetto-More et al. (2010) found that only a small percentage of Computer Science students believed that their high school computing course prepared them to pursue a Computer Science degree. Margolis and Fisher (2003), in their research at Carnegie Mellon University, found that females join IT fields because of their prior successful experience in Maths and Science, or because they have taken and enjoyed programming classes.

The role of prior experience in this study also includes any previous experience in computing fields outside the school curricula, which could influence students to choose a Computer Science major. Cohoon and Aspray (2006) argue that computer experience, either formal such as a computing course at school, or informal such as computer games, will give students initial impressions and information about Computer Science and what it involves. Frequent use of video or computer games was strongly linked to STEM major choices for students in tertiary education, along with some other considerations such as Maths performance scores and socioeconomic status (Lee, 2015). In addition, informal learning about the computing discipline, such as extra-curricular activities, can be a motivation for students to pursue a Computer Science major at university. Lakanen and Kärkkäinen (2019) focused on the outreach program which introduced students to computing fields such as games programming, computational thinking and problem-solving. This program had a generally positive impact on the educational choices of students. In their findings, students who had an interest and intention to pursue a computing major realized that the program had boosted their confidence in doing so, while the other participants, who had previously decided on a major other than computing, stated that their perceptions of Computer Science had changed (Lakanen & Kärkkäinen, 2019). However, Kindsiko et al. (2020) claimed that it was not enough just to deliver one-off initiatives (computer camps and summer schools); the problem was the pedagogical lag in computing classes. Maintaining the ordering of the initiatives is essential, as the students' skills need to be built sequentially, so that enrichment programs cannot be envisaged as one-off programs (Aljughaiman & Ayoub, 2012). Numerous STEM enrichment and enhancement activities, sponsored by the government, private and charitable organizations, were operated in UK schools to enhance the comprehension of STEM subjects and increase pupils' participation. A possible way to evaluate the effect of these activities was to track the proportion of students who achieved a good grade in standardized national tests. Although it was expected that participation in these activities might raise the level of achievement in maths, this did not happen. Achievement in maths was chosen because it is a pre-requisite for obtaining admission to STEM majors (Banerjee, 2017).

It can be argued that the focus should be on schools and their students to try to increase the number of females who choose to pursue a Computer Science major. It is considered better to concentrate on students in the early ages of schooling to promote interest in Computer Science (Brown et al., 2013). Hur et al. (2017) conclude: "we believe that one of the most effective ways to boost girls' interest in Computer Science is to provide computer science experiences in schools. Unless students are specifically taught what Computer Science is and experience that they can be good at it, their participation in Computer Science will continue to be limited. Thus, we encourage schools to provide all students with Computer Science learning experience" (p. 18). If students did well in Computing in high school and had a successful experience, it would be fair to believe that they would be pursuing IT majors and professions (McInerney et al., 2006).

In summary, prior experience seems to be a crucial factor that could influence students to choose Computer Science as a major, so it is important to investigate it more. The review of the literature on prior experience suggests that it can influence educational choices in various ways. The prior experience might be related to Maths, Computing subjects at school, or extra activities outside the school curricula. In line with this literature, prior experiences, as well as the learning environment associated with computing subjects at school, are investigated further in this study for their possible influence on the choice to pursue a Computer Science major by males and females in both contexts.

2.2.3 Social Support

Social support refers to the surrounding environment, such as family and peers, which encourages an individual to study a Computer Science major. SCCT considers the significant role of the environment and the social context in influencing the desires of individuals (Kanny et al., 2014). Some studies have shown the importance of encouragement from others to pursue a particular field. Parents and teachers may play a particular role in promoting and motivating middle and high school students to join the STEM fields (Fouad & Santana, 2017). Teachers and parents need to inspire girls to experiment with IT in middle and high school to attract more women into IT majors and professions by helping them to have interesting and effective IT experiences (McInerney et al., 2006). Other studies found that high school counsellors have had a significant influence on the students' choice of major (Allen, Kumar, Tarasi, & Wilson, 2014; A. Kumar & Kumar, 2013).

Encouragement of students to pursue a specific major may differ based on their gender. There may be more encouragement for males to pursue technical majors, as was found in some previous studies; also, gender is a considered variable in SCCT. Tzu-Ling (2019) reported a significant difference between male and female university students who had already chosen STEM majors in family support, but no significant difference in other variables such as self-efficacy regarding STEM courses or aspirations to pursue a STEM career: male STEM students had more support from their families than their female counterparts who had similar academic abilities. In addition, a study about gender differences among African-American adolescents in technological engagement highlighted that more parents encouraged sons to use technology but restricted daughters, even though the female adolescents reported great confidence in the technology (Tao, Scott, & McCarthy, 2020). The Computer Science students in Funke, Berges, and Hubwieser (2016) study stated that they had been inspired to use computers by other people and the majority of these inspirational people were male, such as fathers or brothers. In the same vein, Varma (2009) found that teachers rarely encouraged female students to choose a Computer Science major, in contrast to the male students who were encouraged to do so.

Contrary to the previous reviews, there are some studies that demonstrate support and encouragement for females as well as males to pursue technical fields. Since the percentage of females majoring in some fields is low, some studies noted the importance and the impact of encouraging girls, in particular, to choose those majors. Mishkin, Wangrowicz, Dori, and Dori (2016) found that female students making an engineering career choice were influenced by social support more than male students. Numerous studies have illustrated the significance of social support in influencing female students to study Computer Science (DuBow, Weidler-Lewis, & Kaminsky, 2016; Teague, 2002; Wilson, 2010). Social support, especially from family, has been identified as a powerful factor leading female students to exposure to and pursuit of Computer Science fields (J. Wang, Hong, Ravitz, & Ivory, 2015). Similarly, Teague (2002) found that the primary factor leading females to choose the Computer Science field was the encouragement they received. Also, Smith, Sobolewska, Bhardwaj, and Fabian (2018) found that both male and female students in Computer Science majors were influenced to make the choice by family and friends. However, Kahle and Schmidt (2004, p. 83) stated: “It appears that most women are not encouraged by others to pursue a computer science career”.

The environment surrounding the students, such as family and school, could play a significant role in encouraging students, particularly females, to pursue a Computer Science major. Increasing the proportion of females interested in STEM fields could be achieved through the spread of more supportive local environments (Legewie & DiPrete, 2014). Margolis and Fisher (2003) argued that the home environment could lead students to be enthusiastic about Computer Science. Moreover, Hur et al. (2017) urged schools to educate parents and guardians as to how their daughters could benefit from Computer Science -related jobs. If parents and guardians understand the essence of Computer Science better, they may provide their children with early opportunities for exposure (Hur et al., 2017). The need for awareness among parents, students, and educators of the importance of learning computer science has also received considerable attention (Google, 2015).

Role models are one of the frequently mentioned factors that influence others. Female role models in Computer Science fields might encourage females to pursue a Computer Science major, which is a focus of this study. Some studies indicate the importance of role models for female students (e.g. Amelink & Creamer, 2010; Beyer & Haller, 2006; Varma, 2010b). A study stated that females had higher grades and lower rates of failure and withdrawal after reading letters of support from women role models (Herrmann et al., 2016). In the field of Computer Science, more female role models are needed. The existence and visibility of females in some STEM fields is lower than in other fields such as Biology, so there is a lack of female role models in Computer Science (S. Cheryan, Master, & Meltzoff, 2015). According to Alvarado and Judson (2014), introducing female students to many of the female role models in computer science could encourage them to pursue a Computer Science major. In addition, other studies found that role models positively influenced students' decision to major in Computer Science, or attracted females to Computer Science (Beaubouef & Zhang, 2011; Black, Curzon, Myketiak, & McOwan, 2011). There are several studies on how to introduce female role models to female students. It has been suggested that showing students female role models, for example by attending the Grace Hopper Conference[3], could change the stereotypes of Computer Science and

[3] https://ghc.anitab.org/, access date: 5/9/2020

enhance the numbers majoring in it (Alvarado & Judson, 2014). Moreover, a project conducted by González-Pérez, de Cabo, and Sáinz (2020) focused on how to increase the ambitions of girls in relation to STEM by connecting them to female role models. Their project featured female role-model sessions in which female STEM volunteers visited schools to talk about their careers. There was a benefit from these sessions in increasing young girls' STEM enrolment, thus indicating a promising method of increasing the number of STEM (González-Pérez et al., 2020). Also, Shin, Levy, and London (2016) found a positive effect of role model exposure through reading STEM role model biographies, in terms of increasing STEM interest and identity among undergraduates.

Together these studies provide valuable insights into the importance of support and encouragement from others in motivating students to pursue a particular major.

However, there are also other studies which found that support from others was not an influential factor. For example, Heinze and Hu (2009) state that support from family and friends is not a powerful factor affecting the intentions of students to pursue careers in IT fields. Social support and role models were not considered the most influential factors for Computer Science students in Kuwait (El-Bahey & Zeid, 2013). In addition, support from others (e.g. parents, peers) was not a significant factor for Computer Science students in the Republic of Armenia and Serbia (Gharibyan & Gunsaulus, 2006; Mirjana, Zoran, Anja, & Zoran, 2010); nor was it a motivational factor for Computer Science students at a university in Estonia (Säde, Suviste, Luik, Tõnisson, & Lepp, 2019).

This study will therefore use SCCT to explore further the role of support from others (e.g., parents and teachers) in influencing students in both contexts, and also to investigate whether students received support and encouragement, and how social support can influence students, particularly females, to pursue a Computer Science major.

2.2.4 Self-efficacy

Self-efficacy is defined by Bandura (1986, p. 391) as “people's judgments of their capabilities to produce designated levels of performance”. According to Social Cognitive Theory (SCT), people can perform tasks based on their capabilities and beliefs (Bandura, 1986). In addition, according to SCCT, self-efficacy has a strong relationship with the act of choosing a major (Lent et al., 2008). McInerney et al. (2006) argued that belief in ability motivates students to perform tasks successfully, which directly influences their choice and performance. Therefore, it can be argued that this ability can play a role in the decision to seek majors and careers in IT.

Self-efficacy for students is one of the important factors that has been examined in multiple studies (e.g. Beyer, 2014; Sapna Cheryan et al., 2016; He & Freeman, 2010; Heinze & Hu, 2009; Wilson, 2010). High self-efficacy for students leads to participation, persistence, and low anxiety when facing difficulties (Schunk & Pajares, 2005). Furthermore, self-efficacy can influence the decisions of students to choose their majors. Correll (2004) confirmed that self-efficacy is important for individuals in choosing their education and occupation. According to Zeldin and Pajares (2000), self-efficacy is an important factor in encouraging females to select and pursue their majors in mathematics, science and technology. Self-efficacy can increase females' intention to pursue computer science (Lips & Temple, 1990). The individual's choices and actions might be influenced by self-efficacy beliefs, as most people are attracted to and pursue the tasks and fields which they feel confident with and have the ability to handle. Pajares (1997) stated that low self-efficacy could make people feel that some tasks are harder than they really are. By contrast, high self-efficacy may make difficult tasks easier and create feelings of calmness in people. Therefore, self-efficacy beliefs are a significant factor in motivating individuals. Students choose the majors and the careers which they feel confident with and qualified in (Pajares, 1997).

Earlier literature about prior experience highlights the role of achievements and previous experience in Computing and Maths in influencing students to choose a Computer Science major. Also, prior experience has been found to influence students' self-efficacy. Computer self-efficacy for female students is influenced by both prior experience and knowledge of computers (He & Freeman, 2010). A study was conducted by Fan and Li (2005) to investigate the gender differences between Computer Science students at a college in Taiwan. They found that, because of prior computer experience which the students had gained before entering college, the female students felt more confident in their ability than male students (Fan & Li, 2005). Prior Maths and programming experiences and accomplishments, as well as students' beliefs about their Maths and programming capabilities, can influence the student's pursuit of a major in Computer Science, especially in the case of females (von Hellens, Nielsen, & Beekhuyzen, 2003).

Lack of self-efficacy and confidence in their abilities might be an influencing factor affecting females in particular that discourages them from choosing computer science. Several studies have reported that female students feel less confident. Goh, Ogan, Ahuja, Herring, and Robinson (2007) showed that females have less confidence than males in the Computer Science field. According to Heinze and Hu (2009) and Beyer (2014), female students have less self-efficacy, interest in and knowledge of computers, and as a result, they are less likely to study a computer science course. Also, according to a Google (2015) report, females are less confident in their skills and less likely to study computer science. Often females' confidence and self-efficacy regarding STEM subjects are less than those of males, even though they perform just as well as males (S. Education, September 2015). Some studies observed that female students classify themselves at a lower level than males in some skills, although they are actually at the same level of abilities and performance. This underestimation can influence the decision of female students to major in Computer Science. Cady and Terrell (2008, p. 278) stated that "positive self-efficacy beliefs are directly associated with persistence. If female students judge their computing abilities poorly, they are not likely to persevere in that field". Lehman, Sax, and Zimmerman (2017b) found that female students in CS rated themselves lower in ability than male students. As cited in Völkel, Wilkowska, and Ziefle (2018), numerous studies affirm that a major factor influencing females against pursuing CS was lack of confidence, as females underestimate their abilities in technical and Maths subjects. Females also rank their academic abilities lower than those of their male counterparts, even among men and women with comparable academic achievements (Völkel et al., 2018). A meta-analysis of studies on gender differences in self-efficacy showed that males demonstrated higher self-efficacy than females in Maths, Computing, and Social Sciences. In contrast, females displayed higher self-efficacy in Language and Arts than males (Huang, 2013). This may be a consequence of the female underrepresentation in the computing field, as Kim, Fann, and Misa-Escalante (2011) argued that female underrepresentation has a negative effect on self-confidence even for those who choose to major in Computer Science. However, von Hellens et al. (2003) found that many of the female students expressed confidence in their ability to succeed, and did not notice any difference between themselves and the male students. But they regarded themselves as less capable in some technical fields.

Students' ability in certain skills may influence their choice of major and increase their confidence in the chosen major. The choice of the sales field for business students was motivated by the high esteem in which students held creativity and people skills, and confidence in their own abilities in these areas (Allen et al., 2014). In a study about the students' choice of college major, aptitude for a subject was an influencing factor for female students (Malgwi, Howe, & Burnaby, 2005). There are certain skills that are usually associated with computing fields, such as problem-solving, so when students find that they have ability in these skills, it might influence their choice of a computer science major. Mathematical skills were usually indicated as a factor in the student's decision to major in Computer Science (Hewner & Mishra, 2016). Students in IT-related majors believed that Maths, problem-solving and analytical skills were important in IT fields (McInerney et al., 2006). The student’s abilities assessment was an important factor in pursuing a Computer Science major. Students in the Völkel et al. (2018) study claimed that they were convinced that they had skills that could be useful for a career in computer science, e.g. mathematical thinking or programming experience.

The creativity and enjoyment aspects of the computing field could also lead students to choose a Computer Science major. Enjoyment of working with computers and technology influenced students to study a CS major (Margolis & Fisher, 2003; Papastergiou, 2008; Yasuhara, 2005). Another study found that enjoyment of the Maths and logic components of Computer Science attracted students to pursue Computer Science (Tillberg & Cohoon, 2005).

In summary, self-efficacy is important in educational choices because individuals who believe in their capabilities and skills in the computing field often decide to choose a Computer Science major. By using SCCT, this study will explore the role of students' self-efficacy beliefs in computing and related skills in influencing them to choose a Computer Science major in both contexts. It has also been suggested that qualitative techniques should be used to explore how self-efficacy beliefs are developed and how these beliefs influence students' academic choices (Pajares, 1997), as well as to find new points of view concerning the self-efficacy beliefs of students (Usher & Pajares, 2008).

2.2.5 Outcome expectation

Outcome expectancy refers to the desired result of an action or behaviour. According to SCCT, outcome expectation plays a role in determining the outcome of a career choice. Lent, Brown, Hackett, & Brown (2002) stated that outcome expectations are considered a key factor in motivating behaviour. It is important to explore students' expectations, either positive or negative, and their perceptions related to the pursuit of academic choices or careers. Moreover, counsellors should be aware of negative expectations, because some of these expectations are misguided or illogical, and may influence students' choices (Shoffner et al., 2015).

Several studies have indicated the connection between the chosen field and career-related expectations and aspirations. Job opportunities, career advancement, and compensation level in the field were influential factors for students in a study about students' choice of college major (Malgwi et al., 2005). According to Clayton (2005) as cited in Chao (2013) there are influential factors in career decisions for students, such as gaining a high wage, creativity, and interesting work. Students of IT-related majors expected that there was a variety of careers and high salaries in the field, and that they could do anything with IT majors (McInerney et al., 2006). Several factors motivate pursuit of an IT field, some of them related to the job, such as: "job security", "income", "opportunity for task variety", "opportunity for job autonomy" and "opportunity for gratifying work" (McKinney, Wilson, Brooks, O'Leary-Kelly, & Hardgrave, 2008).

Career aspirations were found to be an influential factor for students selecting a computing major. A study conducted by El-Bahey and Zeid (2013) examines the attitudes and perceptions of females in computer science and information systems, and the reasons which drove them to study computing majors. According to this study, the most important factor that can lead a student to study computer science is career and future prospects. According to a report by Google (May 2014), career perception can play a role in females’ decision whether or not to pursue computer science. In addition, Zimmerman, Johnson, Wambsgans, and Fuentes (2011) studied the reasons that encourage high school students to choose computer science. By analysing the survey conducted in Latino College Preparatory Academy (LCPA) in California (USA), they found that the strongest factors influencing females to choose computer science were the wish to gain money, experience with computers, and knowing someone in the field. Research that explored the determinants of the choice of field of study, using data from the National Graduate Survey of Canada (NGS), confirms the role of income in the choice of field of study (Boudarbat & Montmarquette, 2009). Moreover, job opportunities, creativity, or communication of these perceptions of computer science attracted female students to pursue Computer Science majors (Funke et al., 2016). However, Heinze and Hu (2009), during their study of the factors that affect the decisions of college undergraduates to study in IT fields, found that male attitudes towards IT professions were more favourable than those of females.

According to a report conducted by Google (2015, p. 17) “most students and parents in the U.S. have a positive image of computer science work”. As the perception of working in the computer field contains a positive image, it may also encourage more females to choose this major.

There are other expectations besides job opportunities that may lead students to choose a Computer Science major. For example, gaining advanced technical knowledge and practical skills, such as programming, were clear expectations of the female students who pursued Computer Science (Völkel et al., 2018). Additionally, Teague (2002) found that female students who decided to study Computer Science were attracted by the practical side of computing. Some students see the computing field as an interdisciplinary field and desire to merge their interests in computing with their interests in other areas. The merging of the Computer Science major with other interesting majors, in particular, may attract more females to pursue the Computer Science major. In order to increase women's representation, computer science and its related disciplines need to adopt new marketing strategies, especially from non-computer courses (Patricia Margaret Alexander et al., 2011). Carter (2006) found that females chose Computer Science because it could be used in other fields. Some students chose to study computer programming because they preferred to integrate it with other fields (Larsen & Stubbs, 2005). A study by Margolis and Fisher (2003), indicated that several females chose a Computer Science major to use with or connect to other areas of benefit to society. Also, female students expressed their reason for choosing a Computer Science major as a desire to make a major impact on their country or globally (Blum, Frieze, Hazzan, & Dias, 2007).

In summary, the literature and SCCT highlight the role of expectations in an individual's choices. So, in this study, it is important to explore the expectations of the students choosing a Computer Science major in both contexts, to see whether they are the same as the expectations reported in the literature, or whether they may have other expectations of the results of choosing a Computer Science major. This study will also investigate whether these expectations influence their decision to major in Computer Science, particularly in the case of female students.

2.2.6 Perception

Perception is not a standard element of the SCCT categories but a factor that emerges from this research study. Perception refers to the students' view of computer science students and their views on how their society in general looks at them. Perceptions of disciplines and their associated careers is considered a factor that could influence students towards the choice of an educational path (Pappas et al., 2016). Thus, it is important to explore perception, which could be an influencing factor potentially affecting the student's choice. Society's perception of students who choose to study a Computer Science major might be positive or negative. In a study conducted by Varma (2010b) to investigate why so few women enrol in Computer Science, she stated: "It is important to get students' thoughts and impressions on the challenges women face to enrol in computer science" (Varma, 2010b, p. 304). So, this study explores the viewpoints of students from different contexts who chose to major in Computer Science, in terms of how they think society views them, and female Computer Science students in particular.

One of the most important perceptions of the Computer Science major and its students concerns computer science stereotypes. Teague (2002) indicated that one of the significant factors leading to female underrepresentation in the Computer Science field is the stereotypes and misperceptions surrounding it. These stereotypes could be about the individuals who study and work in the field or about the field itself. Also, these stereotypes can be a positive or negative influence. Unfortunately, as cited in Beyer (2014), numerous studies find the computer science stereotypes quite negative, particularly towards females. One gender stereotype concerns the Computer Science field as being for males. According to Cundiff, Vescio, Loken, and Lo (2013), a stereotype of the Computer Science major as male dominated may still positively influence the female's persistence in and choice of a Computer Science major. It was found that both boys and girls around the age of 6 held the view that boys are better than girls at programming and robotics, while this stereotype was not applied to other subjects (Master et al., 2017). Vainionpää et al. (2020) conducted a study about females in the IT fields in Finland. They used a discourse lens to analyse the qualitative interview data collected, and they found that massive gender differences are common among young Finnish females when they speak about technology (Vainionpää et al., 2020). As discussed previously, role models seem important in encouraging females to study Computer Science. Also, role models can lead to development in the Computer Science field and change the stereotypes and misconceptions surrounding it (Buzzetto-More et al., 2010). It may be that this negative stereotype of computer science as a "masculine" major, as a result of the high ratio of males in this field, could cause females to feel that that they do not belong in the subject area. Drury, Siy, and Cheryan (2011) found that social stereotypes of females in Maths-related fields were discouraging and prevented a sense of belonging to the field from developing. Some stereotypes about computer science lead females to believe that they do not belong to this field; consequently, females avoid studying Computer Science (Master, Cheryan, & Meltzoff, 2016). However, in some countries, the Computer Science field is not considered a masculine field but is gender balanced, so it seems that they do not subscribe to gender stereotypes of computer science as a male-dominated field. In non-Western nations, some reports indicate higher numbers of females studying and working in the field of Computer Science (Galpin, 2002). Examples of countries with a high percentage of female students in the Computer Science major include Myanmar, 60% and India, 42% (Powell & Chang, 2016). But possibly India and Malaysia are the most-documented examples of the high percentage of women in computer science (Vitores & Gil-Juárez, 2015). The Computer Science field in India is seen as friendly, attractive and suitable for females (Varma, 2010a). Moreover, in Malaysia, females are well represented in the field, accounting for over half the students in computing-related majors. Often, female students and lecturers dominate the Computer Science fields (Mellström, 2009; Powell & Chang, 2016). According to Othman and Latih (2006), there is no gender bias in the way young Malaysians perceive Computer Science. There is a difference between males and females in computer experience and skills before starting the undergraduate degree in Computer Science, but this does not prevent females from excelling and being among the higher achievers in Computer Science fields in Malaysia (Othman & Latih, 2006). The participation of females in Computer Science fields is associated with cultural and environmental circumstances. Blum et al. (2007, p. 2) suggest that "under specific cultural and environmental situations, women fit very well into Computer Science".

In Malaysia, many parents motivate their daughters to study computer science, and many of them follow their parents' advice, even if other majors are favoured (Lagesen, 2006). Also, in India, parents' support for females in choosing Computer Science has a role in interest and persistence in the field and gives females high confidence (Varma, 2011). Here the role of parents and the surrounding environment encourages females (as discussed in the social support section) and helps prevent stereotypes of Computer Science fields from developing. According to Legewie and DiPrete (2014), the local environment plays a significant role in building the strength or weakness of gender stereotypes. Lack of information about science and engineering can strengthen such a stereotype, while knowledge about science and engineering can reduce it (Legewie & DiPrete, 2014).

Some studies argue that the negative stereotype of Computer Science could affect the choice of students to pursue a Computer Science major. Computer Science related fields are perceived as “geeky” (Mikesell & Rinard, 2011; Singh, Allen, Scheckler, & Darlington, 2007). In addition, there are other stereotypical images of Computer Science students, such as being “nerdy” and non-social, and these negative stereotypes could also deter students from majoring in Computer Science, especially females. For example, Sáinz and López-Sáez (2010) found that female students in their study viewed computer scientists as socially isolated, and technology and computers as incompatible with social skills. Computer Science female students in R. M. Powell (2008) study stated that the social isolation associated with Computer Science courses and projects negatively influenced the pursuit of and persistence in studying a Computer Science major. Also, the image of the computer scientist as “nerdy” was found to be a factor which could deter women from pursuing a Computer Science major (Bock et al., 2013; Burge & Suarez, 2005).

To summarize, the literature has presented different and varied perceptions of the Computer Science fields. In this study, it is important to explore the role of these perceptions in influencing students, both males and females, to choose Computer Science in both contexts, especially since Saudi Arabia has no underrepresentation of females in Computer Science fields.

2.3 Chapter Summary

The focus of this research is to explore the role of factors that influenced students, particularly females, to study a Computer Science major at university. This chapter has presented the literature that is relevant to the theoretical background, which is

Social Cognitive Career Theory. It covers a range of potential key factors that might influence the students to study Computer Science. These factors include prior experience, social support, self-efficacy, outcome expectation and perception. The following chapter discusses the study methodology used to interview and survey undergraduates from the contexts of Scotland and Saudi Arabia, in order to explore the role of factors that influence Computer Science students (particularly females) when choosing the Computer Science major.

Chapter 3: Methodology

3.1 Introduction

This research investigated the factors that influenced students, both males and females, to study a Computer Science major at university in two different contexts, Scotland and Saudi Arabia. Both males and females were included in this research to avoid bias and to obtain a wider range of insights from both groups. The aim was to understand the factors that could encourage more females to study Computer Science, particularly in Scotland. The findings from this research will add to existing knowledge about female underrepresentation in Computer Science fields. Knowing the factors that influenced students to study Computer Science could help policymakers to tackle this issue. Moreover, the research involves identifying the factors from the students' point of view in two different contexts, with Saudi Arabia having a gender balance in the Computer Science field, and the differences and similarities between them. This chapter will discuss the methodology and the methods that were used to address the aim of this study. In order to pursue this aim, this study attempts to answer the following research questions:

RQ1: What is the role of prior experience in computing in influencing students to choose to study a Computer Science major?

RQ2: What is the role of social support in influencing students to choose to study a Computer Science major?

RQ3: What is the role of self-efficacy in influencing students to choose to study a Computer Science major?

RQ4: What is the role of outcome expectations in influencing students to choose to study a Computer Science major?

RQ5: What is the role of perceptions of Computer Science in influencing students to choose to study a Computer Science major?

3.2 Research Design

This study used a mixed method approach to investigate the factors that influence students to study Computer Science at university. The mixed methods approach has two phases – qualitative and quantitative – of collecting and analysing data. This approach provides a more comprehensive insight into the research problem compared to the use of a single method (Bowleg, Fielding, Maxwell, & Molina-Azorin, 2016; Creswell & Clark, 2017). In other words, collecting data from two phases, qualitative and quantitative, can give the researchers more ideas and better understanding of the research problem.

There are various types of mixed methods approach. Mark, Philip, and Adrian (2009) categorized mixed methods into two types. The first type consists of collecting and analysing qualitative and quantitative data at the same time and is therefore called parallel. The second type begins either with qualitative or quantitative, is then followed by the other, and is called sequential (Mark et al., 2009). Teddlie and Tashakkori (2008) classified the mixed methods approach into five groups: parallel, sequential, conversion (convert the study's approach into other forms), multilevel (collect qualitative or quantitative data at one level of analysis and use the other approach at another level), and fully integrated (qualitative and quantitative approaches employed together at all stages of the study). However, the most used classification of this approach has been identified by Creswell (2014), who classified mixed methods into two groups: basic and advanced. Basic mixed methods design includes convergent parallel, explanatory sequential, and exploratory sequential. Advanced mixed methods design contains three types: embedded mixed methods design (conducting quantitative, or qualitative, or both, within a larger design such as an experiment or ethnographic study); transformative mixed methods design (incorporating elements of the basic mixed methods designs); and multiphase mixed methods design, which can be conducted by applying several mixed methods in one study.

The importance of the mixed methods approach can be reflected in its steady use by researchers from different disciplines such as information science/systems and education. For example, Bock et al. (2013) used mixed methods to identify barriers that prevent students from choosing to pursue Computer Science at university. Chao (2013) used mixed methods to investigate social, psychological, and motivational factors that accounted for the inequitable representation of females in Computer Science in Australia and Taiwan.

This study used an exploratory sequential mixed method design to investigate the factors that influenced students in Scotland and Saudi Arabia to choose to study Computer Science at university (Figure 1). According to Creswell (2012, p. 543), "The purpose of an exploratory sequential mixed methods design involves the procedure of first gathering qualitative data to explore a phenomenon and then collecting quantitative data".

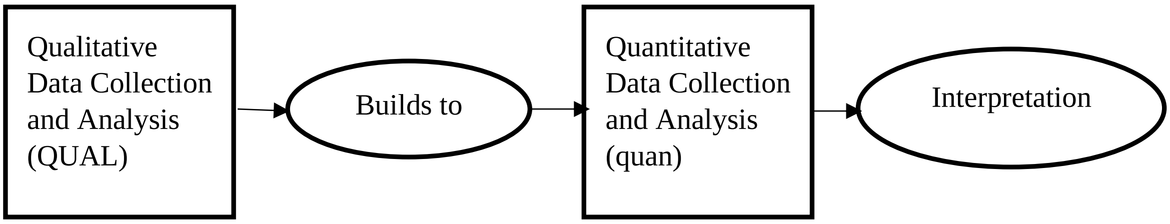

Figure 3-1 Exploratory Sequential Mixed Method Design (Creswell, 2014, p. 270)

So, this design is useful for investigating and understanding a phenomenon by gathering and analysing qualitative data, and then confirming the findings by conducting a quantitative phase (Creswell, 2012). Moreover, it is used to categorize themes and design instruments with which to study a new phenomenon (Creswell, 2012). Another reason for using this design is that the existing variables, measurements, and instruments are not available or known (Creswell, 2012). Interviews and questionnaires are appropriate methodological techniques to explore SCCT factors since interviews provide an opportunity for in-depth information to be gathered, particularly regarding the views and experiences of Computer Science students, whereas the questionnaire aims to validate and broaden the interview findings but with many more participants. Due to the importance of this design, a number of studies have used it to address their research questions and objectives (e.g.Bock et al., 2013; Brdesee, 2013; Gilbert, 2010; Kong, Mohd Yaacob, & Mohd Ariffin, 2018). For example, Bock et al. (2013) used mixed methods to explore the barriers that prevent students from joining a Computer Science major. They started by conducting semi-structured interviews with high school students who were not planning to major in Computer Science and with college students who were not pursuing Computer Science, to obtain more insight about the barriers that kept them from studying or planning to study Computer Science. They developed a questionnaire to obtain data from a larger sample and confirm the findings of the qualitative phase. This study started by conducting a qualitative phase. Semi-structured interviews were used as the method to collect data, and then content analysis was used to analyse the data. In the next stage, a questionnaire was built based on the qualitative findings. The second phase used the quantitative approach to collect data from a larger number of individuals. These two phases are discussed in the next sections.

3.3 Qualitative Study: (Phase 1)

The investigation of a new phenomenon begins with a qualitative approach to define and understand the nature of the research problem. According to Creswell (2012), this approach is considered the best one with which to explore unknown variables and design a new instrument.

In this approach, there are various methods for collecting data such as interviews, observations, stories, journals, or videos (Creswell, 2012). Therefore, Teddlie and Tashakkori (2008, p. 6) defined qualitative methods as “the techniques associated with the gathering, analysis, interpretation, and presentation of narrative information”.

Data analysis in this approach lies in understanding the data in detail to describe what has been learned and to find themes and ideas which emerge from these data (Creswell, 2012; Teddlie & Tashakkori, 2008). These themes and ideas can lead to the answers to research questions and provide depth of understanding of the research phenomenon

(Creswell, 2012). The most common method for analysing data in this approach is content analysis (Zhang, 2017). This point will be discussed in detail in the data analysis section, section 3.3.4 qualitative data analysis.

3.3.1 Qualitative Data Instrument

There are various instruments that can be used in qualitative research, such as interviews (e.g. focus group, face-to-face), observations, documented material (Creswell, 2014; R. Kumar, 2014) and open-ended questionnaires (Hancock, Ockleford, & Windridge, 1998). Thus, an important stage of collecting data is the selection of an appropriate instrument that can help researchers to answer the research questions properly (Vanderstoep & Johnson, 2009).

The most common instrument with which to explore experiences, views, opinions, or beliefs about specific matters is the interview (Britten, 1995). An interview is a conversation which aims to understand a research problem and address its questions (Berg & Lune, 2004). Kaplan and Maxwell (2005, p. 11) state that interviews "elicit the respondent's views and experiences in his or her own terms, rather than to collect data that are simply a choice among pre-established response categories". In this conversation, the researcher has a number of questions and wants the interviewees to answer them (Monette, Sullivan, & DeJong, 2013). According to Burns (2000, p. 423), "an interview is a verbal interchange, often face to face, though the telephone may be used, in which an interviewer tries to elicit information, beliefs or opinions from another person".

The interview instrument is used in research for numerous purposes. It is used to obtain ideas, beliefs, and opinions (Burns, 2000). Moreover, it is useful for reconstructing events and feelings about the research phenomena which can help with future developments (Pickard, 2013). These points make the interview instrument an appropriate way to collect initial data in this study.

Interviews are placed in a number of categories based on the degree of flexibility of the interview (R. Kumar, 2014). There are three types: unstructured interviews, semi-structured interviews, and structured interviews (Berg & Lune, 2004; Burns, 2000; Heigham & Croker, 2009; R. Kumar, 2014; Pickard, 2013). Unstructured interviews are more flexible, offering complete freedom in asking questions, unlike the other two types (Berg & Lune, 2004; R. Kumar, 2014). This type is very useful in the early stage of research for exploring the important issues to be investigated further (Pickard, 2013). In the next type, the flexibility of semi-structured interviews is moderate; here, researchers have a list of questions to cover and can add or remove any questions in order to further address the research questions (Heigham & Croker, 2009; Mark et al., 2009). Because of this moderate flexibility, this type is considered the most common type used for collecting qualitative data (Heigham & Croker, 2009). Structured interviews are very similar to questionnaires, but the researcher needs to ask the interviewees the questions and record their responses (Pickard, 2013). According to R. Kumar (2014, p. 178), this type "provides uniform information, which assures the comparability of data, and requires fewer skills compared with unstructured interviews".

A number of studies have used semi-structured interviews to collect data and address their research questions and objectives concerning factors which have influenced students to pursue a computing major or career (DuBow et al., 2016; Hewner & Mishra, 2016; Teague, 2002; Varma, 2009). For example, Varma (2010b) conducted an interview with 150 undergraduate students (male and female) of computer science and computer engineering about their perceptions as to why so few females enrol in computing. Also, Sax, Zimmerman, Blaney, Toven-Lindsey, and Lehman (2017) conducted a study on the role of department chairs in promoting gender and racial diversity. They used semi-structured interviews with 15 department chairs to address their objective. DuBow et al. (2016) conducted semi-structured interviews with 64 young females who showed interest in computing at high school, to explore the experiences and perceptions of women with regard to computing and their sense of belonging or identity in relation to computing and engineering. Moreover, Blosser (2017) performed semi-structured interviews with 23 professors (males and females) in different majors within the engineering faculty, to examine the reasons for the females' underrepresentation in engineering majors from the faculty members' perspective. Thus, this type of interview will be used for this research.

3.3.2 Qualitative Data Collection

It was mentioned in the previous section that semi-structured interviews enable researchers to obtain opinions and ideas from the participants (Kvale & Brinkmann, 2009). Based on this point, and due to the flexibility of this type of approach, it was decided that it was an appropriate method for collecting data in this research.

SCCT was chosen as a theory to underpin the research based on a review of the literature. In particular, numerous recent studies have used SCCT to investigate factors similar to this study. The academic choice model within SCCT theory was used to design both the interview questions and the survey questions. The interview questions were therefore derived using the 4 main factors from the SCCT academic choice model: outcome expectations, self-efficacy, prior experience, and social support. The interview also contained an additional question to explore any other factors that participants might consider relevant. The interview questions were designed to draw out the participants' beliefs, opinions, and feelings on these topics. Additionally, the semi-structured interview allowed the interviewer and participant to explore further any additional topics that might emerge during the interview.

The researcher discussed the interview questions with her supervisors and some colleagues (academics and researchers). Based on their comments, a number of minor changes were made to the interview questions until the final version of the interview questions, which was deemed to cover the research questions and the aim of this research, was obtained. Before starting the actual interviews, a pilot study was carried out using the draft interview questions with two Computer Science postgraduate students in the Computer and Information Sciences department at University of Strathclyde (one male and one female). This pilot aimed to check key aspects, such as the time taken and whether the wording of the questions was easy to understand. Also, some questions were modified during the interview to obtain more information from interviewees. The final interview questions can be found in Appendix A.

This research attempted to identify the key factors and how they influence pursuit of a Computer Science-related majors, so students taking Computer Science courses were selected as participants. The interview sample was selected by purposive sampling (Teddlie & Yu, 2007). A purposive sample was used to investigate the factors that influence Computer Science students (both males and females) to study Computer Science at university in Scotland or Saudi Arabia. Purposive sampling is a non-probability and non-random sampling strategy (Etikan, Musa, & Alkassim, 2016). Purposive sampling "is a sample chosen 'on purpose' because those sampled meet specific criteria" (Terrell, 2015, p. 75). Thus, the researcher selected the participants for the purpose of this study (Etikan et al., 2016). To address this research, Saudi universities and Scottish universities were selected as a research context. The participants included Computer Science-related majors students from both contexts. The study sample was 'purposive' since only Computer Science students from Scotland and Saudi Arabia were able to provide information about their experience and their point of views in the choice to study a Computer Science major (Creswell & Clark, 2017). The choice of Computer Science students as a sample in this study is not considered to be sample bias but helps the study to address its purpose to explore and understand the factors that influenced them to choose to study a Computer Science major.

However, this sampling strategy has some disadvantages. One disadvantage is researcher bias, due to the fact that participants are selected by researchers themselves based on some assumptions that were made to address their studies. To minimise this threat selection was based on clear criteria – students studying a Computer Science major in Saudi Arabia or Scotland. A more serious potential bias is that students themselves chose to participate in this study and give their views and experiences. These students self-selected and chose to participate. It is quite possible that they held a different set of views and experiences from students who chose not to participate in the study. However, there is little that can be done about such a bias, except to be aware of it and acknowledge it.

The participants were invited to participate in the study by email, the emails being sent to the Computer Science departments at universities in Saudi and Scotland. To recruit more participants in Saudi, a letter was sent via social media platforms to Saudi lecturers who were teaching Computer Science students at Saudi universities. The email and the letter included brief details of the study and the researcher's contact information. Once the researcher received an email from a potential participant in the study, an email was sent to arrange a suitable time and location (for students from Scottish universities), or a time and communication platform (for students from Saudi universities).

3.3.3 Conducting the interviews

The interviews were conducted from October 2017 to January 2018. The day before the interview, the researcher checked with the participants about their availability. In the interview, the researcher first introduced the nature and the purpose of the study to the participants and gave them the interview information sheet, which contained brief details about the study, participants' rights, and contact details for the researcher (Appendix B). Then, the participants were asked to sign the interview consent form (Appendix C).

The interview began with a request for some demographic information. Then, the researcher asked open-ended questions about the participant's prior experience, social support, expectations, self-efficacy, and perceptions of Computer Science. The researcher avoided using unfamiliar terms, such as "self-efficacy"; instead, the terms "feel", "abilities", and "skills" were used. Sometimes extra questions emerged based on the participant's response. At the end, each participant was given time to add any further information. The participants were given a voucher for participation. For students in Saudi Arabia, the questions were translated into Arabic to make them easy and understandable for the participants.

The interviews with students from Scottish universities were conducted at a time and place convenient for them, and took place at a university, the researcher visiting various universities in different cities in Scotland. In contrast, the interviews with students from Saudi universities were conducted at a suitable time for them and online. The average time taken by the interviews was about 30 minutes.

The total number of participants who were interviewed was 28, from both Scotland and Saudi Arabia, all studying a Computer Science related degree. In Scotland there were 17 students (11 females, 5 males, and one MX[4]). They were from different universities in Scotland and different years at the universities. Scottish universities have international students so some of the participants were Scottish, and others were from different countries. In the Saudi context the participants comprised 11 students (8 females and 3 males). They too were from different universities in Saudi Arabia and different years at the universities. All these participants are Saudi. Table 1 and

[4] MX: a person who prefers not to identify as male or female.

Table 2 show more details of the participants, each of whom is assigned an ID by the researcher such as P1, P2 etc. No further participants were interviewed when it appeared that there was no more new information to explore in the interviews. Marshall, Cardon, Poddar, and Fontenot (2013) explain that, when there is redundancy during data gathering and no more new things are being added to the study, the situation is called data saturation. Data saturation is a critical concept in qualitative research, and the appropriate sample size is associated with reaching this saturation. Saturation was reached during the interviews when the same comments were being heard repeatedly with little that was new being added. Grady (1998, p. 26) describes data saturation as “new data tend to be redundant of data already collected. In interviews, when the researcher begins to hear the same comments again and again, data saturation is being reached… It is then time to stop collecting information and to start analysing what has been collected”. Due to the repetition of the responses, it was decided that no further interviews were required. In the literature, there are number of studies which reached saturation using a number of participants similar to the interview study reported here. For example, Jassim and Whitford (2014) argued that if there were no new themes after the 10th interview, this can confirm that the data collection has reached a saturation point. Likewise, Jackson et al. (2000, p. 1406) stated that “following analysis of eight sets of data, data saturation was established… however, two additional participants were recruited to ensure data saturation was achieved”. Also, Kapoor and Gardner-McCune (2019) found that after randomly coding the first nine transcripts of their 14 interviews, they had reached saturation and no new categories arose.

It is also possible to achieve data saturation through data triangulation, where the data in one study helps to confirm the findings in another study (Fusch & Ness, 2015). In the survey study that followed the interview study there was a series of open-ended questions that sought to gather additional thoughts and information not covered by the main body of the questionnaire. Despite the much larger participant coverage no further significant themes / sub-themes arose in the analysis of these questions.

Table 3-1:Participants from Scottish Universities

ID	Gender	Where did they study high school
P1	F	Scotland
P2	F	Latvia
P3	M	Scotland
P4	M	Italy
P5	F	Scotland
P6	M	Scotland
P7	F	England
P8	F	Scotland
P9	MX	Spain
P10	F	Scotland
P11	F	Spain
P12	F	Scotland
P13	F	India
P14	M	England
P15	F	Scotland
P16	F	Scotland
P17	M	Sweden

Table 3-2:Participants from Saudi Universities

ID	Gender	Where did they study high school
S1	M	Saudi Arabia
S2	M	Saudi Arabia
S3	M	Saudi Arabia
S4	F	Saudi Arabia
S5	F	Saudi Arabia
S6	F	Saudi Arabia

S7	F	Saudi Arabia
S8	F	Saudi Arabia
S9	F	Saudi Arabia
S10	F	Saudi Arabia
S11	F	Saudi Arabia

All interviews were recorded using audio recording after getting permission from the participants. The audio recording helped to prevent missing out any important statements that were made during the interviews or misinterpreting the interviewees' statements. This process helped to achieve reliability in the data analysis. The recordings of the interviews were transcribed and entered into NVivo 11 software to conduct the analysis. According to Julien (2008), NVivo is an example of several useful software packages that serve as beneficial tools for handling more substantial quantities of data. These tools can help the researcher in organizing and recording the results but do not reduce the intellectual work of analysing the data (Julien, 2008).

3.3.4 Qualitative Data Analysis

The collected data had to be analysed to understand the topics raised and to try to answer the research questions. There are various methods used by researchers to analyse this type of data. The most common method is qualitative content analysis (Julien, 2008). According to Hsieh and Shannon (2005, p. 1278), content analysis can be defined as "a research method for the subjective interpretation of the content of the text data through the systematic classification process of coding and identifying themes or patterns". The content analysis describes a systematic search for terms and concepts that suit a coding structure (categories) defined by the research problem or research questions (Flick, 2009). Also, it is "the intellectual process of categorizing qualitative textual data into clusters of similar entities, or conceptual categories, to identify consistent patterns and relationships between variables or themes" (Julien, 2008, p. 120). The themes in this type of analysis can be previously identified and the researcher then seeks the evidence to support these themes (Zhang, 2017). Thus, these themes are used as units for analysis and can be expressed in a single word, paragraph, sentence, or phrase (Zhang, 2017). Coding for qualitative data can be driven from theory, previous knowledge, or developed inductively during the analysis (Kaplan & Maxwell, 2005). In this study coding themes were identified from the SCCT plus one further theme that was added during data analysis - perception. Content analysis was used to analyse the qualitative data in the interview phase.

According to Hsieh and Shannon (2005), content analysis contains three approaches: conventional, directed, and summative. As this study applied the theoretical framework of social cognitive career theory (SCCT), the researcher used directed content analysis, which is considered the appropriate approach for validating a conceptual theory or theoretical framework (Hsieh & Shannon, 2005). This type of analysis can be conducted in three stages: preparation, organization, and reporting (Elo & Kyngäs, 2008). The personal coding process used in the study contained several stages. First the researcher read the transcript and listened to the audio recording for each interview at the same time. This procedure helped to verify the accuracy of the transcripts. Then all the transcript files were uploaded to NVivo 11 software, which is generally considered a useful software package to manage qualitative analysis. In the second step, nodes were created in NVivo. Each node represented a theme adapted from SCCT: prior experience, social support, self-efficacy, and outcome expectations.

In the third step, each interview transcript was read carefully. Any phrases, keywords, or statements from the transcript related to any of these themes (nodes), were highlighted and transferred into the target theme using NVivo – see the screenshot below.

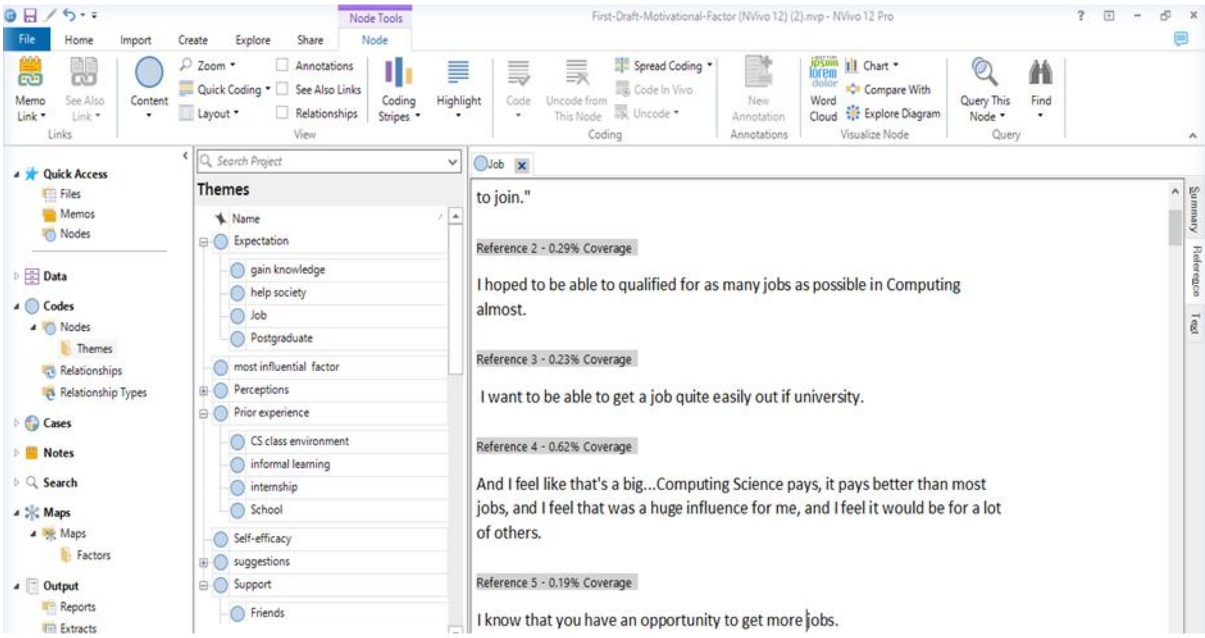

Figure 3-2 Screenshot from NVivo software

In the fourth step, the same transcript was re-read to explore any new themes that should be created or new subthemes that could be grouped under these main themes. In this step, one new main theme was identified - perception. A number of subthemes were also identified for some themes. These were based on the repeated mention of specific topics within a theme e.g., job within outcome expectations. Thus, there are five main themes in this study, four of them were from SCCT, with one further theme perception created from the data, as shown in Table 3-3.

Table 3-3 Themes and sub-themes for the qualitative phase

Main Themes	**SCCT/ Data**	**Subthemes**
Prior Experiences	SCCT	Formal Learning (School)
		Informal Learning
		Computing class environment
		Internship
Social Support	SCCT	Teachers
		Parents
		Friends
		Others
Outcome Expectations	SCCT	Job
		Gaining Knowledge
		Help Society
		Doing Postgraduate Study
Self-efficacy	SCCT	-------
Perception	Data	Characteristics of CS students
		Society

Table 3-4 shows the outcome expectations theme and its sub-themes, along with some quotes taken from the interviews (via NVivo) which correspond to those sub-themes.

Table 3-4 Outcome expectation theme and its sub-themes

Main Theme	**Subthemes**	**Examples of participants' responses**
Outcome Expectations	Job	- "Computing Science pays, it pays better than most jobs, and I feel that was huge influence for me". - "There are a lot of good, well-paid jobs that are available. So yes, it would influence people to get into Computer Science". - "I knew that Computer Science would give me more options of jobs".
	Gaining Knowledge	- "I think it gives you skills that put you in a very good position. I think it just gives you very useful skills that really put you ahead in life". - "So far, I have learned a lot of programming languages and web design. I have done a lot of projects, so this gives me more experience".
	Help Society	- "Doing something beneficial to society, and maybe discovering something or making something really good which would

		be beneficial for everyone. That is my expectation". - "Computer Science is an excellent major which could develop the community through studying this major, so I expect to create software that will help people".
	Doing Postgraduate Study	- "I was considering taking maybe a postgraduate course". - "Pursue a master's degree in different fields such as accounting".

In the fifth step the final report from the NVivo was printed containing all the themes, sub-themes, and the supporting evidence – see the report snippets of two participants for the job sub-theme below.

Nodes\\Themes\\Expectation\Job

Document

Internals\\Interviews\\P1

And it was like "there's a lot of job opportunities that we'd love to have women on our team." So he said "if you do decide to st Computer Science there would be better job opportunities because teams are looking for women to join."

I hoped to be able to qualified for as many jobs as possible in Computing almost.

I want to be able to get a job quite easily out if university.

And I feel like that's a big...Computing Science pays, it pays better than most jobs, and I feel that was a huge influence for me, a it would be for a lot of others.

I know that you have an opportunity to get more jobs.

Internals\\Interviews\\P2

I'm going to say a very good salary. And infinite career choices, because I could go anywhere. Anywhere in the world and in any industry, so there's a lot of flexibility.

Literally, we can go anywhere. If we just learn a little bit of extra knowledge about the new industry, we go into. Couple that wi computer knowledge, and we can go anywhere

In the sixth step, the report was discussed with thesis supervisors and other colleagues who had experience of this research approach. They were asked to review the themes, subthemes and the responses that supported them. There were no major changes made as a result of this review, and the findings were reported as shown in Chapter 4. In analysing the interview data, one additional theme arose where responses could not be categorised within the 4 SCCT academic choice factors - perceptions of computing held by participants, their family, and society more generally. Additionally, interview participants also identified a variety of valuable suggestions that might be used to increase female participation, and these were not categorised as a factor affecting participation.

The researcher asked for help from a native speaker to transcribe 17 audio recordings of interviews conducted with students from Scottish universities (Appendix D). In the case of interviews conducted with 11 students from Saudi universities, the researcher transcribed them in Arabic. The researcher read through the Arabic transcripts for Saudi participants and highlighted the relevant quotes. These quotes were then translated into English.

3.4 Quantitative Study: (Phase 2)

As mentioned previously in this chapter, this research applied a sequential exploratory mixed methods design. This section will discuss the second phase of this design, which was a quantitative study. The quantitative approach is used to explain phenomena, testing hypotheses and theories (Muijs, 2010), or to generalize to a large sample of the population (Creswell, 2014) and to validate the qualitative findings, in a process called triangulation (Yeasmin & Rahman, 2012). This approach is conducted by collecting numerical data and analysing them using statistical techniques (Muijs, 2010). A number of studies have used this approach to address their research questions and objectives concerning the factors that influence students to study a particular course (e.g. Beyer, 2014; Geyfman, Force, & Davis, 2016; He & Freeman, 2010; Heinze & Hu, 2009; A. Kumar & Kumar, 2013; Lehman et al., 2017b; Pappas et al., 2016; Wilson, 2010). The data collection was conducted using a questionnaire which was built based on the findings of the first phase. The researcher built the items of the questionnaire from the participants' responses in the interviews. The steps in developing the questionnaire are explained in the following subsection.

3.4.1 Quantitative Data Instrument

The questionnaire was based on the qualitative findings and was constructed to collect more information from a large number of participants from both contexts. The questionnaire in chapter 5 was developed to validate and explore further the qualitative data that was obtained in the initial interview phase of the research (chapter 4). This questionnaire was not designed for the purpose of testing hypotheses or relationships between factors. It was solely intended to validate and substantiate the findings of the initial study with a much broader participant base and to uncover any further useful findings. The questionnaire was only designed with the purpose of applying descriptive statistics to the results of the individual questions. The research was not intended to focus on relationships between these factors. The questionnaire went through several steps in its development. According to Creswell (2014), the processes of developing the questionnaire from qualitative findings can be conducted by employing the quotes, codes, and themes to build items, variables, and scales. Therefore, the researcher conducted a number of steps to develop the questionnaire in order to carry out the second phase of the study. These steps are described in the following points.

Step 1: it began with identifying items, variables, and scales, as shown in the example of outcome expectations items in Table 3. The initial draft of the questionnaire was built by writing down these items, variables, and scales in a Word document. This initial draft was then discussed with the supervisors and other colleagues who had experience and skills in developing questionnaires.

Step 2: based on the comments and feedback received from the supervisors and colleagues, a number of changes were made. Then, an online survey tool, Qualtrics, was used to design the questionnaire.

Step 3: after the questionnaire was designed in Qualtrics, a copy was sent to the supervisors to review and give feedback about the design of the online version of the questionnaire. In addition, copies of the questionnaire were sent to three academic staff in the Computer and Information Sciences department at the University of Strathclyde who had good experience in quantitative research, and who were asked to evaluate the flow and design of the questionnaire.

Step 4: based on the evaluations from the supervisors and the three academic staff, a number of changes related to the design and flow of the questionnaire were made. Then, the final design of the questionnaire was shown to the supervisors, and they confirmed the final version.

Step 5: the final version of the questionnaire was translated into Arabic by the researcher, who then reviewed the translated version with two Saudi professionals in linguistics and translation. Next, the researcher asked three Saudi researchers to read and evaluate the Arabic version of the questionnaire.

Step 6: a pilot version of the questionnaire was completed by five Computer Science postgraduates, who were asked to determine whether the wording of the questions was easy to understand; also, the time taken to answer the questionnaire was recorded.

Step 7: the researcher sent the Arabic version to students in Saudi universities, while the English version was sent to students in Scottish universities. The final versions of the questionnaire can be found in Appendix F.

Table 3-5 :Example of items for expectation theme

Examples of participants' words/phrases (Quote)	Sub-theme
I think there are quite a lot of good, well-paid jobs that are available. So yes, it would influence people to getting into Computer Science	Career Path
Some people want to study Computer Science to get a job	
Computer Science pays better than most jobs, and I feel that was a huge influence for me	
I knew that Computer Science would give me more options of jobs, because most jobs involve computers	
I think you have more, a wider variety, of jobs	
I am going to say a very good salary. And infinite career choices	
Have my own company	
You can be self-employed, do your own apps, make your own things	
You can go from designing and building computers to building apps, making software	
I also think it gives you skills, puts you in a very good position, for example you can create an app or create a website	Gain Knowledge
I expect learning and analysing how exactly computers work	
Learning how to program	
Learning new stuff	
Is to fill up the holes I have from my self-taught experience	
Obviously gaining knowledge	
I learnt about a couple of interesting things at the end and I know about many and that is all I expect, really	
Maybe doing benefits to society, and maybe discovering something or making something really good which would be beneficial for everyone. That is my expectation	Help Society
Learning about how things that make our society go round work	
Kind of helping society as a whole moving forward and stay on the edge of technology and helping to ensure it all runs smoothly and helping society to run as a whole	
I was considering taking maybe a postgraduate course	Postgraduate study
I would really like to do a Master's in computer science	

3.4.2 Quantitative Data Collection

As mentioned in the previous subsection, the online survey tool Qualtrics was used to collect data in this phase. The questionnaire was open for five months (October 2018 to February 2019).

This type of questionnaire has several advantages over the traditional paper-based type. For example, online questionnaires are easy to use and not expensive compared with the traditional method (Evans & Mathur, 2005; Harlow, 2010; Van Selm & Jankowski, 2006). This allows the researcher to collect data from participants from one place or different places, in one country or many countries, and from a large sample (Evans & Mathur, 2005). They are also more flexible than traditional questionnaires (Evans & Mathur, 2005; Harlow, 2010). According to Harlow (2010, p. 98) “because online surveys provide the ability to transfer survey responses directly into a database, transcription errors are eliminated”.

Because of the qualitative nature of this study, so the questionnaire was used to validate the findings that were obtained from the qualitative study in the first phase and to generalize them (Creswell, 2014). Another important reason for using the questionnaire was to get a broad range of information from a large number of participants (Muijs, 2010).

The quantitative phase of research was once again based on the SCCT academic choice model, with questions based on the additional perception factor, suggestions for improving female participation, and the option to include any further participant thoughts not covered by these topics. The sub-themes identified in the interview study allowed more refined questions to be explored in the survey based on these sub-themes. Therefore, the questionnaire consisted of closed and open-ended questions, to allow the participants to add more information and share their experience. One question asked the participants whether or not they had studied a Computing subject at school. If a participant selected “No” they were asked some questions which were different from the questions asked of those who selected “Yes”. The questionnaire contained a number of questions about each of the following categories: prior experience, social support, self-efficacy, outcome expectations, perceptions, background information, and demographic information. The prior experience category contains items about the students' experience in computing fields before university, such as a Computing subject at school, or informal learning of computing outside of school. The social support category includes items about the encouragement that was received from others. The self-efficacy category consisted of items about skills, feelings, and abilities. The outcome expectations category asked about the expectancy associated with choosing the Computer Science major. In the perception category there were items about society’s views of Computer Science students and the Computer Science major. Also, there were open-ended questions about the factors that could encourage or discourage students from choosing to study Computer Science. The last section included background and demographic information. The final version of the questionnaire is in Appendix G.

In the questionnaire, there were a number of questions that measured responses by five-point Likert scales in which 1 = “Strongly disagree” and 5 = “Strongly agree”; 1 = “Very difficult” and 5 = “Very easy”; 1 = “Extremely negative” and 5 = “Extremely positive”; 1 = “Extremely unsure” and 5 = “Extremely confident”; 1 = “Very poor” and 5 = “Excellent”. There were also questions which allowed the participants to select either a single choice or all the options that applied. In addition, there were open-ended questions which gave the participants space to state their opinions and experiences, and to follow up on closed-question topics.

At the end of the questionnaire there was an opportunity for all the participants to enter the draw for five prizes, namely five gift cards from Amazon (£10 each). The questionnaire was distributed to a purposive sample of students from both contexts, who studied Computer Science at universities. The researcher sent an email to colleges and departments of Computer Science at universities in Scotland and Saudi Arabia. The email contained brief details about the researcher and her study and included the link to the questionnaire. Also, the researcher used some social media platforms such as Facebook and WhatsApp to recruit participants to the study.

The total number of participants who responded to and completed the questionnaire was 192 from 4 universities in Scotland and 341 from 10 universities in Saudi Arabia. The samples for both phases were drawn from similar populations, purposive sampling of Computer Science students in Saudi Arabia and Scotland. The main difference was that the second study (survey) had a much larger sample with the aim of investigating and validating the main themes that were identified in the interview study. The samples for qualitative (interview) and quantitative (survey) phases are not the same (Creswell, 2014). Normally, the qualitative sample is much smaller than a quantitative sample. They can, however, be drawn from the same population, especially, as in this case, when the quantitative (questionnaire) study seeks to strengthen the qualitative (interview) phase.

3.4.3 Quantitative Data Analysis

There are several types of statistical methods that can be used to analyse this kind of data. Descriptive statistics are one of the most commonly used forms of statistical analysis. According to Fisher and Marshall (2009, p. 97), “Descriptive statistics provide us with a useful strategy for summarising data and providing a description of the sample but cannot provide information for causal analysis”. Moreover, they provide frequency distributions to characterize the data, rather than testing propositions (Cliff & King, 1996). This questionnaire was not designed for testing hypotheses or testing relationships between factors. It was solely intended to validate and substantiate the initial study's findings with a much broader participant base and uncover any valuable findings. The survey was only designed with the purpose of applying descriptive statistics to the results of the individual questions. The research was not intended to focus on relationships between these factors. As this study did not test any hypotheses, the descriptive statistic is a suitable method for analysing the quantitative data for the current study, as shown in Appendix G, which is an example of quantitative data analysis. (Terrell, 2015, p. 99) states that “you do not include a hypothesis in a descriptive design simply because you are not examining the relationship between variables or testing cause and effect. Instead, you’re answering your research questions by using descriptive statistics”. As this study focuses on exploring and understanding the factors that influence students to choose to study computing, and does not test any hypotheses, the use of descriptive statistics is a suitable method for analysing the quantitative data from the current study. Although, the purpose of using the questionnaire was to validate the first interview phase, additional analysis has been carried out to explore whether the difference between male and female responses is statistically significant. In applying such analysis care has to be taken because of the skewed number of females compared to males. Due to the ordinal and skewed nature of the data, the Kruskal-Wallis test, as suggested by SPSS, was used for this analysis (Grace-Martin, 2020).

To analyse the collected data, SPSS 24 Software and Excel 2016 were used. Frequency distributions were used to analyse the data and answer the research questions. The results are presented in Chapter 5, Quantitative Findings.

3.5 Validity and Reliability

Validity and reliability are fundamental in any research, whether quantitative or qualitative. It is important for each study to establish the validity and reliability of the collected data (Creswell, 2014). Validity focuses on the accuracy of the findings, whereas reliability focuses on their consistency and trustworthiness (Gibbs, 2008). Also, validity is the extent to which the questionnaire accurately measures what it is intended to measure (Heale & Twycross, 2015). Reliability focuses on the consistency of the items of the questionnaire and whether these items are stable over time (Bryman, 2012). There are various ways to check the validity of qualitative and quantitative data. The validity of the research was ensured using the following approaches. This research used detailed descriptions which can convey the findings and provide a coherent discussion of the collected data (Creswell, 2014). The researcher also asked some senior researchers who were not familiar with the study to provide their comments and feedback about the relationship between the research questions and data, the level of data analysis, and the interpretation of the findings (Creswell, 2014). For the questionnaire, the researcher addressed content validity by asking some senior researchers who have experience in the field to validate whether or not the instrument measured all aspects of the construct (Heale & Twycross, 2015). Thus, the content validity for the questionnaire was achieved at the questionnaire's development stage, when the researcher asked a number of senior researchers in the field to review it. All the details on this point were discussed in this chapter, 3.4.1 quantitative data instrument. In addition, purposive sampling helps the researcher to choose cases that reflect the researcher's focus of interest (Silverman & Data, 2001). In this research, the researcher only chose Computer Science students, not randomly, in two contexts. This means that the researcher will gain information about the factors that influence students to pursue a Computer Science major from relevant participants who chose to study Computer Science. A helpful method for enhancing generalization in qualitative research is to study more than one case (Bryman, 1988). Moreover, this can help one to minimize the negative effect of single sources on research validity by collecting different viewpoints on the same subject (Parry, 1998). The researcher investigated the factors affecting both males and females in different universities in two different contexts. She used the quantitative study to validate the qualitative data (mixed method); this process is called triangulation which is considered one of the effective ways to validate data (Creswell, 2014; Silverman, 2015).

Regarding the reliability of the collected data, a number of methods were applied. The first step in the process was checking the transcripts to avoid any mistakes that may have occurred during transcription (Gibbs, 2008). The transcripts were read, and the audio recordings listened to at the same time to verify the accuracy of these transcripts. Moreover, the researcher read the transcripts several times before and after coding to make sure that the codes had not changed in their definition and meaning during the process of coding (Gibbs, 2008). Also, the supervisors reviewed the transcripts and the resultant codes to try to ensure consistency in the categorization process. The research procedure needs to be explicitly documented by the researcher to meet the reliability criterion (Franklin & Ballan, 2001; LeCompte & Goetz, 1982). An audit trail is critical for providing a basis on which to inspect the reliability of the research method (Franklin & Ballan, 2001). Without detailed identification and a comprehensive explanation of the methods used to obtain and interpret data, replicability is unlikely (LeCompte & Goetz, 1982). The procedure for the data collection and data analysis is explained in detail in this chapter. In addition, there is a test which can be used to determine reliability in a quantitative study, according to Bryman (2012, p. 170): “Nowadays, most researchers use a test of internal reliability known as Cronbach’s alpha. Its use has grown as a result of its incorporation into computer software for quantitative data analysis”. Cronbach's alpha value is appropriate for determining internal consistency in exploratory research when it is higher than 0.60 (Straub, Boudreau, & Gefen, 2004). Therefore, Cronbach’s alpha has been calculated for some items to achieve internal reliability for the questionnaire’s items in this study. For example, Cronbach’s alpha for self-efficacy is 0.68, and for social support is 0.69. Finally, triangulation, which strengthens reliability and internal validity (Creswell, 2014), is another step that the researcher used to test the reliability of the collected data.

3.6 Research Ethical Statement

This type of research involves human participation. Therefore, it was important to obtain ethical approval in both studies before conducting the data collection. This participation leads to a number of ethical considerations (Babbie, 2013; Creswell, 2014), including the following points:

- The participation was voluntary.
- A consent form for each study was provided within the study.
- Participants could withdraw at any point in the study.
- All the information and responses' details were treated confidentially, and no identification of participants was stored or reported in the study.
- Only the researcher and her supervisors would have access to data, while the audio files for interviews would be deleted after the project was completed.
- The findings of the research will only be used for the purposes of the research.

The ethical approval for both studies was granted by the University of Strathclyde's Departmental Ethics Committee in Computer and Information Sciences, the application IDs are: 620 and 799.

3.7 Chapter Summary

This chapter has discussed the methodology and the methods that were used to address the questions of this research, which was conducted by an exploratory sequential mixed methods design. Thus, the study began by using the qualitative approach to collect and analyse data. Based on the findings of the qualitative study, a quantitative questionnaire instrument was developed to conduct the second phase. In addition, there were a number of important concepts involved in both studies, such as methods for collecting and analysing data, the sample, the analysis software, and finally ethical approval. The next two chapters will present in detail the results of the qualitative and quantitative studies.

Chapter 4: Qualitative Findings

4.1 Introduction

This research aims to investigate the factors that influenced students (males and females) to choose to study a Computer Science major at university in two different contexts: Scotland and Saudi Arabia. This chapter presents the findings of the data collected by the qualitative approach, using semi-structured interviews.

The participants in this phase were from both contexts, Scotland, and Saudi Arabia. The total number of participants was 28 students, all studying Computer Science majors. In Scotland there were 17 students (11 females, 5 males, and one MX[5]), from different universities in Scotland and different years at the universities. Scottish universities contain international students, so some of the participants are Scottish and others are from different countries. In the Saudi context the participants were 11 students (8 females and 3 males), also from different universities in Saudi Arabia and different years at the universities. All these students are Saudi. Each participant has an ID which is used instead of their names to make the data confidential. For example, the first participant in Scotland is assigned the ID "P1", while the ID for participants in Saudi Arabia used the letter “S”. Also, the letters "F" and "M" indicated the gender, male or female. The demographic information for these participants is shown in Table 1 and Table 2.

[5] a person who prefers not to identify as male or female.

Table 4-1 Characteristics of Participants in Scotland

ID	Gender	Where did they study in high school
P1	F	Scotland
P2	F	Latvia
P3	M	Scotland
P4	M	Italy
P5	F	Scotland
P6	M	Scotland
P7	F	England
P8	F	Scotland
P9	MX	Spain
P10	F	Scotland
P11	F	Spain
P12	F	Scotland
P13	F	India
P14	M	England
P15	F	Scotland
P16	F	Scotland
P17	M	Sweden

Table 4-2 Characteristics of Participants in Saudi Arabia

ID	Gender	Where did they study in high school
S1	M	Saudi Arabia
S2	M	Saudi Arabia
S3	M	Saudi Arabia
S4	F	Saudi Arabia
S5	F	Saudi Arabia
S6	F	Saudi Arabia
S7	F	Saudi Arabia
S8	F	Saudi Arabia
S9	F	Saudi Arabia
S10	F	Saudi Arabia
S11	F	Saudi Arabia

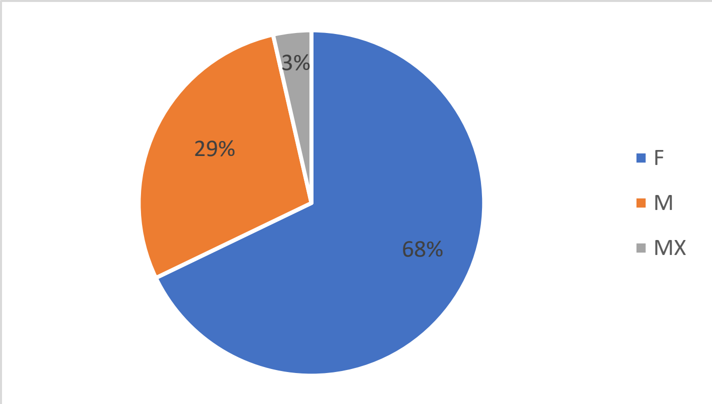

Figure 4-1 Gender of the participants

4.2 Coding and Analysis

Directed content analysis was used to analyse the interview transcripts, as described in Chapter 3: Methodology, with reference to the qualitative data analysis. In this analysis, the data were categorized into four themes based on elements of SCCT: prior experience, social support, self-efficacy, and outcome expectation, in addition to the theme of the perception. There were suggestions from the participants' responses to schools and universities to attract more females in Computer Science fields, but these suggestions were not added as an influencing factor. Therefore, the following sections present the role of these factors in influencing the students to choose to study a Computer Science-related major at university in the two contexts, Scotland, and Saudi Arabia.

4.3 Prior Experience

Prior experience refers to previous experience of learning any Computing subject and discipline, either through formal learning, such as a Computing subject at school, or informal learning outside school. This main theme includes a number of sub-themes that emerged from the students' responses about their experience before university. These sub-themes are shown in the following points.

4.3.1 Formal learning

Formal learning refers to learning any computing discipline in a formal way before studying a Computer Science major at university, such as studying Computing subjects at school. It is considered one of the important ways to inform prior experience. This can be found from the participants' responses, in which most of the participants in Scotland stated that they had taken a Computing subject at school, and all the participants in Saudi Arabia had taken a Computing subject. However, there were noteworthy differences in the computing curriculum studied.

- **Computing Subject at School**

The participants who did have Computing at school mentioned the computing curriculum, which was placed into three categories based on their responses regarding the disciplines they studied.

- First category: the Computing curriculum included a significant amount of programming. In Scotland a few of the participants stated that they had covered a lot of programming topics at school and gained programming experience there, whereas in Saudi Arabia the participants did not mention this point.

The following examples from the participants at Scottish universities illustrate this:

"I had a good teacher who did a lot of extra projects with us, and we got to do a lot of programming; we learned Python as a part of the course in school" (Participant P5 (F)).

"*I had a really good experience when I took Computer Science in my high school. Inside the school we had C++ and we had Python, SQL, and basic network terminologies. We did a lot of C++ for two years. And all of that encouraged me to take up Computer Science in my university*" (Participant P13 (F)).

- Second Category: the Computing curriculum includes the basics of programming. In Scotland, some participants mentioned the basics of programming. For instance, participant P10 (F) said:

"*We only did Basic. We used Visual Basic, but we were quite limited. We didn't get taught programming.*"

Similarly, in Saudi Arabia some of the participants stated that the basics of programming were included in the Computing subjects studied. The following interview excerpts illustrate this:

"*We studied a very simple part of programming with Visual Basic, and the maximum thing about the programming was control statements*" (Participant S7 (F)).

"*We had a simple basic programming language such as using Visual Basic*" (Participant S4 (F)).

- Third Category: The Computing curriculum just included applications. In both contexts, Scotland and Saudi Arabia, some participants reported that the computing disciplines which they learned at schools did not go beyond Information Technology and how to use applications. The following interview excerpts demonstrate that:

"*We just did Microsoft programs, no coding or anything like that, it would just be IT"* (Participant P7 (F)).

"*In school we did simple things in the Computing subject, such as Word, Excel and at the end of third year we had a very simple website design. We did not have enough practical at school"* (Participant S6 (F)).

Therefore, some of the participants in Scotland and in Saudi Arabia did not consider the Computing curriculum at school to be related to the Computer Science major at university. This is seen in the following interview excerpts:

"*It was mainly just learning what the internet is and internet safety. We didn't really do much actual Computing until I came to university*" (Participant P15 (F)).

"*The Computing curriculum at school was totally different from the Computer Science at university; at school just applications, no algorithms or problem solving. The subjects were mostly theoretical*" (Participant S7 (F)).

Thus, in Saudi Arabia some participants stated that they were surprised by the Computer Science major at the university. The following participants' responses illustrate this:

"*I was shocked in the course at the university because it is quite different from the Computing subject I was studying in secondary school. It is good to have a programming part in the curriculum, especially for the students who intend to pursue Computer Science at university and let them know about the major as there will be intense programming*" (Participant S6 (F)).

"*During the first year in CS major I was shocked because I did not have any idea about the subjects, it is different from the high school curriculum*" (Participant S10 (F)).

In Scotland, two of the participants had a computing subject at high school only when they moved from abroad to Scotland in the last year of high school. These two participants said:

"I didn't do any Computer Science at school until I moved here" (Participant P8 (F)).

"*I only did a Computing here in Scotland, and that was just focusing on the main concepts in Computer Science. And then we did a little bit of coding, and we did Visual Basic, which was not the most practical language, I think that was a bit discouraging*" (Participant P12 (F)).

The previous section demonstrated the Computing curriculum at schools based on the participants' responses in both contexts, Scotland and Saudi Arabia. However, in Scotland, a few of the participants also never did any Computing subject in high school, as the following interview excerpts show:

"*I didn't actually take it at school, I thought it was a bit useless, to be honest*" (Participant P3 (M)).

"*There was no interaction with computers at all in my high school. We did not even have a computer lab. That is not because my school is bad. It was very traditional*" (Participant P4 (M)).

"*I just wish my high school had introduced me to it earlier*" (Participant P11 (F)).

According to the participants' responses in this study, a Computing subject at school was not the only formal learning pursued by the participants before choosing a Computer Science major. The responses reveal that there are other courses in computing outside the school that were taken by the participants before they chose a Computer Science major. These courses can be divided into two categories as follows, based on the responses from the two contexts:

- Preparatory year at Saudi universities:

Some of the participants in Saudi Arabia mentioned their experience of Computing subjects in a preparatory year at their universities, which was considered informative for them in deciding to study a Computer Science major. The following interview excerpts exemplify this:

"*We did not have enough practical at school, thus in the preparatory year at the university we were introduced to programming and problem solving; then I decided to choose a CS major*" (Participant S9 (F)).

"*When I was at school, I planned to choose one of three majors: translation, management or Computer Science. After the preparatory year, I decided to choose a Computer Science major*" (Participant S6 (F)).

- Changed Majors in Scotland:

In Scotland two participants decided to change their majors at university when they were introduced to Computer Science subjects in the first year. The following interviews show this:

"*It was when I took my first Computer Science course, which was programming in my first year at the university when I was in math major. I thought it was so cool and so creative. Because I had no idea what programming was. So, I think that was the moment when I decided oh, I want to study Computer Science*" (Participant P11 (F)).

"*I actually did a year of Physics, and I really didn't enjoy it. I also took the Computing course (Introduction to Java), and I liked it. So, then I swapped to do Computer Science major*" (Participant P15 (F)).

4.3.2 Informal Learning

Informal learning refers to any experience through which the participants get to learn computing disciplines in an informal way, prior to choosing a Computer Science major. Some of the participants in both contexts, Scotland and Saudi Arabia, confirmed that they obtained their experience of computing outside the school, such as through online courses, or by self-instruction.

For online courses, the following excerpts exemplify this:

"*Outside I used a Code Academy course to learn Python*" (Participant P6 (M)).

"*During summer I had online courses in programming and ethical hacking, with the 'Rwaq*[6] *' platform*" (Participant S10 (F)).

The following examples of interview excerpts illustrate other kinds of informal learning reported by some of the participants in Scotland:

"*Before university I had an experience by myself, with a couple of friends. But not in an academic setting. I worked as a Software Developer before coming to university. And while I first met C, and then I met a couple of friends and they used Python, so I was introduced to that. And because Python is a very welcoming language, I started using it*" (Participant P9 (MX)).

"*I got accepted for a Google developer scholarship before I came to university, so I sort of learned the basics of programming*" (Participant P16 (F)).

Moreover, in Scotland two of the participants did an internship related to Computer Science during high school, after which they decided to study Computer Science. The following interviews show this:

"*I went to a company and did a four-week internship where I did some Computer Science stuff in a real working environment. That's when I decided to choose it*" (Participant P1 (F)).

"*I had an internship at the end of it, I really, really liked it. And it worked. I think that did obviously reinforce my idea that oh, going on to do a Computer Science degree would probably be a good thing*" (Participant P6 (M)).

[6] "Rwaq" is an Arabic platform for online courses, rwaq.org

However, no participants from Saudi Arabia had or mentioned an internship during high school.

4.3.3 Learning Environment

The classroom environment in which students learn is significant. So, the participants talked about what the environment of the Computing classroom at school was like, and their impression of it. Some points emerged about the Computing class environment at school: the gender of the majority of the students in the class, the optional or mandatory nature of the subject, and whether the class was fun or boring.

Concerning the gender of the majority of the students in computing class at school, some of the participants in Scotland stated that the majority were males, and the following excerpts exemplify that:

"*It was very weird for me to go in, because I was the only girl, especially for S4. Plus, it is a very quiet classroom. Most of them did not want to do it at university. They just did it because they had their friends that were doing it, so it was a very social thing for them*" (Participant P1 (F)).

"*In my Higher class in fifth year, there was only one other girl*" (Participant P5 (F)).

"*In Higher in our year, there was only one female, and she dropped out almost immediately. And in Advanced Higher there was only eight of us, all boys*" (Participant P6 (M))

"*The majority was guys, but there were maybe five or six girls, in the class*" (Participant P12 (F)).

However, in Scotland a few of the participants stated that because the computing subject in their school was mandatory, the computing class was considered gender-balanced, as the following interview excerpts demonstrate:

"*It was fine. It was a mandatory class, so it wasn't really male-dominated because people didn't pick it, they just had to do it*" (Participant P16 (F)).

"*You cannot choose subjects, you study that. It is compulsory. So, all the girls were there*" (Participant P2 (F)).

In Saudi Arabia, due to the education system, which is based on the single-gender school, the participants did not mention the gender of the students in the computing class.

Moreover, the Computing subject at Saudi schools is mandatory, so all the participants had a Computing subject at school.

As for the participants' responses about the Computing class environment, some of the participants in Saudi Arabia described it as fun, for example:

"*Computing class was fun, not learning, we liked it*" (Participant S3 (M)).

"*Computing class was fine for me*" (Participant S4 (F)).

Other participants described the Computing class as boring due to the topics studied; the following interview excerpts show this:

"*The Computing class was boring, there was nothing new, we already know the topics which was about word processing etc*." (Participant S10 (F)).

"*The topics in high school were simple, and not new for us. In some cases, we felt bored. Moreover, the class was 2 hours, thus the time was long, and we finished early and played games*" (Participant S6 (F)).

"*The Computing curriculum at school is weak. Thus, the students did not take the Computing subject seriously*" (Participant S1 (M)).

However, in Scotland, some of the participants described the Computing class as fun and open to discussion, which the following interview excerpts illustrate:

"*It was quite fun. We were divided into groups, so we were sitting together discussing things*" (Participant P12 (F)).

"*It was good, because it tended to be smaller classes, and so we had a lot more discussion and would always be very interactive with the teacher and we would get the chance to practice things*" (Participant P5 (F)).

"*It was a good environment. It was fun as well. It was quite open to discussion, which was nice*" (Participant P7 (F)).

"*There was no pressure. It was really calm"* (Participant P13 (F)).

It can be argued that prior experience in computing before university may be considered an influential factor that motivated the students to pursue a Computer Science major at university. Some of the participants, in both contexts, argued that they had had experience of Computer Science disciplines before university. This experience may have influenced them to pursue a Computer Science major. For example, a participant explained her experience as follows:

"*I had a really good experience when I took Computer Science in my high school. So, I knew all along that I really wanted to do Computer Science and nothing else. And all of that encouraged me to take up Computer Science in my university*" (Participant P13 (F)).

In addition, a participant described how the programming part influenced her:

"*Just the simple part of programming at school influenced me, and I start to like and enjoy the computing; when I had free time in school, I went to the computer lab and used Visual Basic, and when the computer teacher saw me keen on programming, she helped me and gave me new things to implement and understand it*" (Participant S7 (F)).

Another participant described her own experience:

"Not the Computing subject experience that influenced me to study Computer Science at the university, it's my own experience by working on computer at home and in some activities in the school, I'm using Adobe Photoshop for designing, I know it's not programming. I participated in a competition for a logo design" (Participant S10 (F)).

However, some participants stated that their prior experience had not influenced them to pursue a Computer Science major. The following interview excerpts show this:

"*My experience with Computing at school did not influence me to study Computer Science major*" (Participant S4 (F)).

"*I don't think it would have made much difference for me personally because I was already interested and knew a fair bit*" (Participant P17, (M)).

To sum up, the previous sections presented the findings based on the participants' responses about their experience in computing before choosing to study Computer Science at university. In Scotland only some of the participants had a computing subject in school, but in Saudi Arabia all the participants did. A significant amount of programming was mentioned only in Scotland, but the simple basics of programming and applications in both contexts were mentioned in both Scotland and Saudi Arabia. The Computing subject, which is taught in the preparatory year at Saudi universities, and in the first year in other majors at some Scottish universities, influenced some of the participants to study a Computer Science major. With regard to informal learning, some of the participants in Scotland reported being self-taught, using online courses or having an internship, whereas in Saudi Arabia a few of the participants mentioned online courses.

Moreover, the participants in Saudi Arabia did not refer to the gender of the majority of the students in the Computing class during school, while in Scotland the majority of students in the computing class were males. The word “fun” was used by some of the students to describe the Computing class environment in both contexts, but “boring” was used by some of the participants in Saudi Arabia. All the participants in Saudi Arabia had a computing subject at school because of the compulsory nature of the subject, while it was optional for most of the participants in Scotland. Also, it can be argued that the computing subject at school did not seem to have a significant influence on most of the participants in choosing Computer Science. Nevertheless, there are other experiences besides the school curricula which may influence the participants.

4.4 Social Support

The Social support theme refers to the encouragement that is received from others, which might influence the student's choice to pursue Computer Science major. This support can come from family, teachers, and friends. The following sections demonstrate this support based on the participants' responses.

- **Family**

The parent or any family member can encourage the student to pursue a computing major. This point has been mentioned by a number of the participants in both contexts, Scotland and Saudi Arabia. The following interview excerpts exemplify the father's role in proposing a Computer Science major:

"*My dad didn't want me to do Maths and he suggested Computer Science*" (Participant P8 (F)).

"*My dad told me that you like Math, so it's good to study Computer Science because it's combined between Math and technology*" (Participant S9 (F)).

Other participants reported encouragement received from their parent:

"*My parents were always supportive when I was talking about it, I guess. They didn't have to suggest it because I was the first person to come up with it, but they were very happy and excited about the choice*" (Participant P12 (F)).

"*Well, my family don't really know much about it. My mum was just supportive that I went to university anyway*" (Participant P1 (F)).

A participant who came from a computer science family stated:

"*My dad did Computer Science. My mum did too. But my dad's the main one, and he encourages it because he knows it's useful*" (Participant P15 (F)).

Other participants stated that their parents noticed their interest in computers and so encouraged them to pursue Computer Science. The following excerpts show this:

"*When I mentioned it to my parents, they obviously thought yeah, that's really good, you're talented at that*" (Participant P5 (F)).

"*My parents supported me, and they said that since I was a child, I used to play with the computer*" (Participant S8 (F)).

Moreover, some of the participants stated that they had received encouragement to pursue a Computer Science major from family members including a brother, cousins, and an uncle. For example:

"*My brother, who is a teaching assistant in the Computer Science department at the university, encouraged and advised me to study Computer Science*" (Participant S7 (F)).

"*My cousin who kind of influenced me in my early years*" (Participant P13 (F)).

"*My cousin is a Computer Science student, and she convinced me to study it and she answered my queries about the Computer Science major*" (Participant S4 (F)).

"*My uncle studied Computer Science, so he said you'll like it, you'll enjoy it. So, he kind of helped me decide to do Computer Science*" (Participant P10 (F)).

However, one participant clarified that:

"*To be honest, I did not receive any encouragement from my family to study Computer Science at university*" (Participant S11 (F)).

- **Teachers**

Teachers are another supportive factor that could influence the students' choice to pursue computing. In Scotland, some of the participants stated that they had received encouragement from high school teachers. The following examples demonstrate the role of the computing teacher:

"*I think, in my case, the fact that the teacher had made it sound very interesting and important, especially the problem-solving part, that I really enjoyed it. It made it a really clear choice for me to go and study Computer Science. So, I think the teacher does a lot*" (Participant P12 (F)).

In another example, the Maths teacher was mentioned:

"I did ask my Maths teachers in high school that I wanted to do something related to Maths, but not Maths and not any engineering and they suggested Computer Science. And that is when I chose the subject the year after, to do Computer Science. And that is when I really, really fell in love with it" (Participant P8, (F)).

However, among the Saudi participants only one mentioned her computing teacher at preparatory year at the university; she said:

"*A teacher in preparatory year encouraged me, and she made me think about a Computer Science major*" (Participant S9 (F)).

Some of the participants in both contexts, Scotland and Saudi Arabia, asserted that their computing teachers were their favourite teachers in school. For instance:

"*I actually really enjoyed the teacher I was with. He was just a really fun teacher to have*" (Participant P1 (F).

"*My computing teacher was my favourite teacher, I liked her*" (Participant S5 (F)).

- **Others**

In Scotland, others provided encouragement to some of the participants. One participant who had an internship during high school demonstrated that when she said: "*Only through the internship. I was given a mentor who, he really encouraged me to do Computing because I had an interest in it. And he was like 'you should do it'. He works in Computing, and he said: 'it would be a really good job opportunity, a good career path'* (Participant P1 (F)).

Another participant mentioned a different person who talked to him before university: "*One of my dad's friends, I went to talk to before university, because he actually works in the industry, he works in Computer Engineering*" (Participant P14 (M)).

Furthermore, one participant stated that his friends had influenced him to study Computer Science:

"*I have quite a few friends who study and work in Computer-related subjects. They told me about what they were learning, so I want to do that*" (Participant P17 (M)).

It can be argued that families and schools can play an important role in encouraging students to pursue a Computer Science major. According to the responses in both contexts, in regard to the role, influence was divided between family and school, or came from both of them. The following excerpts exemplify some responses which asserted that the role depends more on the parents:

"*I think there lies more responsibility on society, and particularly on families and parents more than universities. Because universities can only interact and talk to people that already come to them. So, there has to be some work done before that*" (Participant P9 (MX)).

“*Provide opportunities. So, as a parent, some parents send their kids to dance, but you should maybe send your kids to program*” (Participant P2 (F)).

“*For example, since childhood, the parents can provide and give their kids games that help them to analysis and think, so that might be making their thinking close to programming and problem-solving*” (Participant S7 (F)).

“*The role of the parents is important especially for the students who do not know what majors they would like to choose, so sometimes students need suggestions from others*” (Participant S4 (F)).

Another participant took a different view, namely that the role depends more on school than on parents:

“*I think parents should encourage people to try something different, but I think it's more the school that should be doing that rather than the parents, because it's what you're doing at school that's important, not what your parents want you to learn*” (Participant P10 (F)).

Some of the participants discussed how others, either schools or parents, can play a role in encouraging and influencing the students’ choice to pursue Computer Science as a major at university.

The following interview excerpts explain how parents or teachers can influence students:

“*I think when you're young and you're choosing what to study at university, you don’t have much idea of what the work’s really like or where certain degrees can take you.*

So, if your parents say one thing or your teachers say one thing, you are very likely to listen to them a lot. So, if they tell you 'oh, Computer Science is not for you', you probably think that is true. Or if they tell you it is, you probably think 'oh, I should go and do it'. So, I think they can have a very big influence in what you end up studying" (Participant P11 (F)).

"*The role of parents in persuading their kids for choosing the major, for example, my dad said you could read and think about Computer Science you may like it. Also, the role of teachers is to give extra exciting information to the students, and by encouraging the students to read and search more about the major*" (Participant S9 (F)).

"*I believe the most important role is played by the teacher. If the teacher is really good at his job or her job, then it makes the student more comfortable. And a further role is played by the parents because we interact with parents on a day-to-day basis. And the counsellor of course they show you the part, how to reach there. I think all three, my parents, my counsellor and my teacher, they played an important role in me choosing Computer Science*" (Participant P13 (F)).

Some of the participants argued that, if the parents or teachers demonstrate and highlight the strengths of students and how good they are in some fields, then that could influence their choices. The following interview excerpts show this:

"*I think if they point out your strengths, and what you're good at, I think that makes a real difference. For me, other people said, 'you're really good at this', and it kind of makes me happy*" (Participant P5 (F)).

"*If my parent did not encourage me to choose Computer Science, I did not choose it, especially when I was confused, which major to study. Parents give you suggestions based on your ability and personality*" (Participant S10 (F)).

"*I think a lot of students don't know what they are good at. So, if they are told they are good, then they will believe they are good. And if they told they are not, then that is what they will believe*" (Participant P9 (MX)).

To sum up, the role and the influence of social support on the students' decisions to choose to study Computer Science seems to be significant. In both contexts, numerous participants had received encouragement from families to pursue Computer Science. Some of the participants in Scotland, particularly females, mentioned their teachers in high school. However, for Saudi participants, only a few referred to their teachers, and no one mentioned friends, while a participant in Scotland mentioned friends. Thus, there were varied sources of social support for the participants in Scotland. Most of the participants demonstrated the role of support from others, either parents or teachers, and how that would be beneficial in encouraging students to pursue a Computer Science major.

4.5 Self-efficacy

The self-efficacy theme comprises participants' beliefs about their abilities, emotions, and skills in their decision to study a Computer Science major.

Regarding the participants' confidence in their abilities to study Computer Science, some of those in Scotland reported that they had background and skills in Maths and Computing topics, which could increase their confidence. The following examples from interview excerpts show this:

"*I had very little of a Computing background, but I really enjoyed Maths, I did a few Maths competitions, which are purely based on problem-solving. And I feel more confident about the Computing part, so I am very confident*" (Participant P12 (F)).

"*I had a Maths background, which was quite useful coming into this, I'm gaining confidence in myself as I go along*" (Participant P14 (M)).

"*I think I'm good with problem-solving. I have always been good with problem-solving, and about Maths, is not my strong point, but I can do it when I try. But you can do anything as long as you try, so I do not think that will stop me*" (Participant P10 (F)).

Some participants in Scotland only mentioned their feelings and skills in relation to programming. For example:

"*I do really, really like doing programming*" (Participant P6 (M)).

"*I have been the chief in my high school development of the students' week. So, I have had to create a whole system for students to sign up in courses and create their own courses. So, I have abilities in the web sector*" (Participant P4 (M)).

"*Before University, I could do programming in C++. I could do a bit of SQL, and Maths was one of my main subjects in high school, I could do a lot of problem solving as well, so I am quite confident actually in my ability*" (Participant P13 (F)).

Some of the participants mentioned that they were confident in their ability to study Computer Science, without any mention of their skills.

"*I was one of the best students in the school. I heard that Computer Science major is difficult and not easy to graduate from it, but I was confident in my ability to study it*" (Participant S6 (F)).

"*Confident, I had no skills in programming or Computer Science before I came here, and so far, I've done well, better than I expected*" (Participant P17 (M)).

"*I have great confidence in my abilities to study Computer Science, I see it an easy major, I like it, and I did not have any skills in computing before university*" (Participant S3 (M)).

A few of the female participants in Scotland expressed a lack of confidence in regard to their experience and skills. A participant who came from abroad explained why she did not have confidence:

"*I didn't have it at school. And most people who live here had it at school and it was a normal subject. So, I am not very confident in my ability*" (Participant P8 (F)).

Another female participant stated that:

“*I'm not confident, I'm struggling. It is not easy. I would not say I have skills; I am on my way to gaining skills*” (Participant P2 (F)).

The following two examples express doubt about the students’ mathematical ability, as they said:

“*The only downside for me is just the Maths”* (Participant P16 (F)).

“My confidence in my Maths ability kind of hinders me” (Participant P1 (F))

As emotions are related to the self-efficacy concept, there were positive and negative emotions described by the participants in both contexts, based on their experience and feelings about studying Computer Science. Examples of the feelings identified by the participants include: good, great, happy, stressed, scared, and challenged. The following interview excerpts demonstrate these feelings:

“*My experience in high school, it made me scared of Computer Science, because I did get good grades, but it was very hard. You have to think too much, there is too much Maths. And only this one smart guy could do it. And I do not think I am that smart. I'm not confident*” (Participant P2 (F)).

“*My confidence at the beginning was zero, but now I’m confident and happy. At the first semester, I faced difficulties, and I fail in one subject, then I changed and achieved better*” (Participant S8 (F)).

A participant reported his confidence despite having less experience in Computer Science; he stated: “*Personally I'm coming in with less experience than a lot of people because I haven't done Computing in school. But I feel like that should level off in the second year. Because I am doing a lot of stuff in my own time with the university* *syllabus to try and catch up. So, I am conservatively optimistic that, yeah, I'll hopefully get the Bachelor and maybe the Master*" (Participant P3 (M)).

Other participants described their feelings about their choice of studying Computer Science as follows:

"*I'm happy in CS. It is a good and powerful major*" (Participant S2 (M)).

"*I am completely satisfied, and I did not regret my choice to study Computer Science*" (Participant S10 (F)).

Some participants had mixed emotions, which might be based on their mood and feelings in certain situations during their study. The following two examples identified a range of emotions:

"*Sometimes empowered, sometimes it's a struggle for me. I think it is a hard degree. When you compare it to other degrees, I think it is quite hard. But at the same time, I am quite happy because it gives me so many possibilities. So, in that sense I feel very lucky*" (Participant P11 (F)).

"*It makes me feel different because I'm a woman doing Computer Science, because people would normally not guess that that's what I'm studying. But it also makes me feel interesting, in a way, since again I am a woman, but I enjoy the subject*" (Participant P8 (F)).

A participant discussing her feelings said:

"*I was feeling a bit stressed. And I was angry because I was, like, am I not good enough to do this course? It's kind of I feel stressed, and then someone explains and then I feel better*" (Participant P1 (F)).

Some participants mentioned the challenges arising during their study of the Computer Science major, often in a positive sense. The following interview excerpts reveal this:

"*Sometimes I'm tired. But I am never frustrated, I am never sad that I'm doing it because it makes me feel happy. So, I feel challenged, I take the challenge positively. I complete it, and then the result makes me happy*" (Participant P13 (F)).

"*Challenged, a lot of the time. There is a lot of challenges in it. And that does make me motivated to do more and do better*" (Participant P5 (F)).

"*Some topics were difficult at the beginning, which I feel challenged, and put pressure on me and made me think about changing the major, while others are easy and enjoyable*" (Participant S4 (F)).

Some of the participants related their enjoyment in creating and building new things to their study of a Computer Science major. The following interview excerpts demonstrate this:

"*My passion was driven by the love of creation. So, I loved what I created, and I wanted to know more to create more*" (Participant P4 (M)).

"*I really enjoyed doing the programming and building my own things*" (Participant P5 (F)).

"*I like to explore and create something new, so I think Computer Science major suits me*" (Participant S10 (F)).

According to the participants' responses, it can be argued that it is important to have a particular passion and some skills, such as problem-solving, when choosing to study a Computer Science major. For example:

"*I think if you're good at problem-solving then you would like Computer Science or Maths because they're strongly connected. If you like programming, you should consider CS*" (Participant P10 (F)).

"The important thing is the passion towards studying Computing" (Participant S3 (M)).

A female participant reported that:

"*Anyone who enjoys problem-solving has the ability and motivation to do Computing. A lot of people are put off by a lack of programming knowledge, and I think if they understood that you just need to start with an ability to learn and understand things, then you can really do quite well in a way*" (Participant P5 (F)).

Some participants suggested that it was not necessary to have studied Computer Science before coming to university. The following interview excerpts are examples of how some students can pursue Computer Science without any of these skills:

"*These skills are important, but if the student has not these skills, so it is not a reason to prevent the student from study Computer Science major. Because these things will be obtained and learned and not necessary to know before*" (Participant S7 (F)).

"*Before university, I did not have the abilities and skills that qualify me to study Computer Science. In the preparatory year, I liked the subject. I like things related to development*" (Participant S6 (F)).

"*In the beginning, I had simple skills, but now I see improvement in my skills, I think it's not important to have skills before university. They will get and have skills when they get to university*" (Participant S2 (M)).

"*At the beginning of the university, I just had basic skills, but afterwards, I am excellent in some topics*" (Participant S1 (M)).

"*The course is done in the way that you can start from scratch, and you can build up the skills with almost no background*" (Participant P12 (F)).

To sum up, there were similarities and differences between the participants in both contexts in regard to the self-efficacy factor. In Scotland only, some of the participants mentioned their skills in Maths and programming as an example; while some of the participants, both in Saudi Arabia and in Scotland, stated that they felt confident in their abilities in studying Computer Science without mentioning any skills. However, a lack of confidence was expressed by some female participants in Scotland only.

Some of the participants in both contexts related their enjoyment in creating and building new things to their study of a Computer Science major. Also, some participants in both contexts argued for the importance of having a passion and some skills such as problem-solving before choosing a Computer Science major. In contrast, others said that it was not essential for students to have some skills before studying Computer Science at university. The positive and negative emotions experienced while studying Computer Science seemed to be similar for the participants in both contexts. However, a prior interest in Computer Science was mentioned by some of the participants in Scotland only.

4.6 Outcome Expectations

Outcome expectations are the results the participants expected from pursuing a computer science major. These expectations were grouped into three sub-themes based on the participants' responses: career options with Computer Science, gaining knowledge of Computer Science and helping society.

4.6.1 Career Options

Career options which were expected to be obtained with a Computer Science degree were mentioned by most of the participants in both contexts; the expectations included better and varied jobs, good pay, and getting a job quickly. The following interview excerpts show some participants' responses regarding pay:

"*Computing Science pays, it pays better than most jobs, and I feel that was a huge influence for me, and I feel it would be for a lot of others*" (Participant P1 (F)).

"*There are a lot of good, well-paid jobs that are available. So yes, it would influence people to get into Computer Science*" (Participant P14 (M)).

Examples of the expected variety of jobs in the labour market to be obtained with a Computer Science degree are:

"*I knew that Computer Science would give me more options of jobs because most jobs involve computers*" (Participant P10 (F)).

"*I expect to get a job. I see most students choose to study Computer Science major because the chances for Computer Science graduates to get a job is guaranteed*" (Participant S7 (F)).

Some of the participants stated that they would consider owning a business or mentioned the possibility of becoming self-employed or developing their own apps with a Computer Science degree. For example:

"*My personal dream is to start my own company and begin to produce something which is a product that people will eventually use*" (Participant P4 (M)).

"*I hope to establish my own business*" (Participant S8 (F)).

"*You can be self-employed, do your own apps, and make your own things*" (Participant P5 (F)).

In both contexts, Scotland and Saudi Arabia, a number of participants stated that, because of the career opportunities, they chose to study a computing major at university instead of the subjects that had been their favourites at school. This was explored based on the response to the question about the favourite subject at school and the reason why, if it was not computing, they did not choose to study it at university. An example is provided by participants who reported that they chose a Computer Science major over Art and History due to the job prospects, saying:

"*There's plenty of jobs available in it. I'm quite lucky that I enjoy Computing rather than Art because Art is a lot harder to get a job in at the end*" (Participant P5 (F)).

"*I thought the only thing I would get out of studying a degree in the Liberal Arts would be enjoyment. And I do not really think I could make a career out of English. It does not take me anywhere I really want to go. So, I decided not to pursue it*" (Participant P16 (F)).

"*I didn't see a clear career path with History*" (Participant P3 (M)).

Other participants mentioned that their favourite subjects at school were science and Maths, but that they did not see future jobs resulting from these. The following interview responses illustrate this:

"*My favourite subject at school was Science in general, such as Chemistry and Biology. I did not choose it at university because I did not see any future job with it like Computer Science*" (Participant S7 (F)).

"*I would like to study a major that helps me to shape my future better. Maths, which was my favourite subject at school, does not have a good career path in the future, and Computer Science is a part of maths, so Computer Science and Maths are related*" (Participant S2 (M)).

Two of the participants expressed their opinions regarding the favourite subject and the major at university in relation to the availability of jobs. The following interview excerpts show their responses:

"*I think it's important to study something that you like, but at the end of the day, you want to have earned a living and have money because you need money to live, so if you can study something that is going to give you that peace of mind, I don't know, I think that's something that's going to encourage you to study it*" (Participant P11 (F)).

"*I chose a major which has a good career path. It is hard to study a major even if you like it, and it is your favourite, but it does not have a good career path*" (Participant S3 (M)).

4.6.2 Gaining Knowledge

The other result that some of the participants in both contexts expected from pursuing Computer Science was satisfaction of the desire to gain knowledge in Computer Science fields. An example of the value of Computer Science knowledge is provided by the following excerpt:

"*I think it gives you skills that put you in a very good position. I think it just gives you very useful skills that really put you ahead in life*" (Participant P11 (F)).

A participant in Saudi Arabia noted the improvement in her English language besides the programming skills; as she explained:

"*So far, I have learned a lot of programming languages and web design. I have done a lot of projects, so this gives me more experience. Also, my English has developed as well as my programming skills*" (Participant S6 (F)).

Some of the participants clearly expected to be:

"*A programmer*" (Participant S7 (F)), or

"*A web developer*" (Participant S8 (F)).

"*I would like to get a Cisco certificate*" (Participant S2 (M)).

Some of the participants planned to complete postgraduate study. The postgraduate studies mentioned by the participants varied, as shown in the following interview excerpts:

"*I was considering taking maybe a postgraduate course*" (Participant P1 (F)).

"*If I cannot find a job, I will complete a master's degree*" (Participant S7 (F)).

One participant mentioned the master's degree in a different major, saying:

"*Pursue a master's degree in different fields such as accounting*" (Participant S4 (F)).

4.6.3 Helping Society

A few of the participants in Scotland and one participant in Saudi Arabia expected to help society by creating and doing something useful. The following responses indicated this:

"*Doing something beneficial to society, and maybe discovering something or making something really good which would be beneficial for everyone. That is my expectation*" (Participant P13 (F)).

"*I would like to change the world and leave a mark*" (Participant P4 (M)).

"*Computer Science is an excellent major which could develop the community through studying this major, so I expect to create software that will help people*" (Participant S5 (F)).

To sum up, the expectations from studying Computer Science for participants in both contexts are similar in including career options, gaining knowledge, and helping society. For the majority of participants, the main expectation in choosing to study Computer Science was the career options available with a Computer Science degree. Gaining knowledge with Computer Science was second, and a few of the participants considered helping society with a Computer Science degree. Choosing a major such as Computer Science that offered good pay and availability of jobs played a significant role for the participants, as was shown explicitly by the responses about choosing Computer Science instead of their favourite subjects.

4.7 Perception

The perception theme is not part of SCCT, but it created during the data analysis as an important theme from participants' responses.

Society's perceptions of Computer Science were identified. There were positive and negative thoughts, as described by the participants. The positive perceptions were reported by the participants in Saudi Arabia as, for example:

"*I think society is proud of Computer Science students, and a Computer Science major is considered as one of the high standard majors such as engineering and medicine*" (Participant S7 (F)).

"S*ociety has a positive perception of Computer Science as a powerful major*" (Participant S2 (M)).

However, other participants in Scotland described some negative perceptions and the bias of society towards females in the Computer Science major, as the following interview excerpts reveal:

"*There are stereotypes regarding Computing, that it's a man's subject and women should not do it, even though Ada Lovelace was the first programmer ever. She was a woman. So personally, I do not have any biases or preferences, as long as you're good at the subject*" (Participant P17 (M)).

"*In society, it might be still that women are a bit pushed away from science; they aren't supported as much as they could be. I think it is seen as more of a boys' thing which could be a bit more generally true. But personally, from what I have seen, I think girls* *are discouraged from it, I think girls are not encouraged into it enough*" (Participant P14 (M)).

"*I can't say from family to family, but I think society definitely. I think in the USA, I think more females are being pushed there, but in the UK it's still quite underdeveloped in terms of pushing females in STEM subjects, so I think*" (Participant P16 (F)).

"*In the society I grew up in, there is discrimination*" (Participant P4 (M)).

A participant reported the situation in his class as follows:

"*I think there is a bit of bias still for women in Computing Science. I am happy to say that in my class it is roughly half split, and we are all as equally knowledgeable as each other, and there is no real bias in that regard. But I think in wider society as a whole, especially in kind of the old guard of Computer Science, there is still a bit of a stereotype, and a bias. I think there is still a bias against women programmers, in particular. I do not know about other areas, but I would say there is a particular bias against women in programming, even though it's completely ridiculous*" (Participant P6 (M)).

A few of the participants mentioned that society regards Computer Science students just as people who can fix hardware or give technical support. For example:

"*They think we can repair hardware and stuff*" (Participant P1 (F)).

"*Some people think that Computer Science major is just entering data and does not go beyond applications, such as word processing*" (Participant S1 (M)).

"*I think some people see Computer Science fields could be a talent and anyone can get it without studying it at university, but others see Computer Science a powerful major*" (Participant S9 (F)).

Another perception that emerged was that of the family, which tended to be more negative in Scotland and positive in Saudi Arabia. The following interview excerpts illustrate some of the negative perceptions:

"*It depends on family; lots of parents see Computer Science as a very boring job. I have lots of friends (girl) whose parents would never let them do Computing Science because they think it's a very guy job*" (Participant P12 (F)).

"*In my case, my parents maybe wanted me to be more Maths and be a teacher, or study maybe Biology; that kind of thing was what my family wanted me to study. But Computer Science was never something that was mentioned*" (Participant P11 (F)).

"*I wouldn't say there is a difference between getting support if you're a female or a male. At least me, I get excellent support. But I think in many cases, if you look around, you will see, probably people think it is a more of a boys' thing, and not exactly a girls' thing. But that is just an ideology; that is just a belief. But I do not think I have ever seen anyone not support a girl because that girl is pursuing Computer Science*" (Participant P13 (F)).

In Saudi Arabia, some participants mentioned the positive attitude of family towards Computer Science compared to the negative attitude towards medical majors. The following interview excerpts demonstrate this:

"*There is no difference between boys and girls to study a Computer Science major, but I think there is a difference in other majors such as Law, and medical majors, where some families do not prefer this subject for girls*" (Participant S4 (F)).

"*There is no difference in Computer Science. The difference may be in medical majors*" (Participant S3 (M)).

"*There is a difference in support; some families encourage girls to study Computer Science rather than Medicine and encourage boys to study Engineering and Medicine rather than Computer Science*" (Participant S6 (F)).

However, some participants in Scotland noted that females were more likely to be encouraged to study business subjects. For example:

"*In my school, I don't know why, but a lot of girls were encouraged to do admin, which is much easier than Computing*" (Participant P1 (F)).

"*Most girls I think do business*" (Participant P10 (F)).

It can be argued that Computer Science is considered a male-dominated major in Scotland, but not in Saudi Arabia. The following examples of interview excerpts from Scotland demonstrate this:

"*It's a fact. Because more guys study it. I think because guys are more encouraged to do it. They have more opportunities. Well, maybe we have equal opportunities, but guys are pushed towards it*" (Participant P2 (F)).

"*Because of the attitudes in society that Computer Science have always been male-dominated, and something that is dominated by one gender tends to stay in that way because women might feel singled out, or worried that they won't be able to do it*" (Participant P17 (M)).

"*It's just because of the same societal thing that computers are for males. That is what society thinks. And males are the ones that are supposed to do programming, all these things that seem kind of geeky and nerdy. But I do not think it should be like that. I think females could be very, very good at programming, probably even better than males*" (Participant P8 (F)).

A participant explained how the male-dominated majors can be discouraging for females:

"*One thing that would discourage me from studying Computer Science would be thinking that I would be surrounded mostly by males, because that would make me feel a little bit uncomfortable as a woman. I would like to have girls around me, and friends. I would never like to be the only girl in the room, or anything like that which is the case for me a lot of the time now, but as a young girl, that would be very discouraging*" (Participant P11 (F)).

Regarding Computer Science as a male-dominated major, the participants in Saudi Arabia see a lot of females studying Computer Science, and the Computer Science major is not considered male-dominated, for example:

"*In the past, there were a few females in the Computer Science field, but now a lot of females study Computer Science*" (Participant S8 (F)).

"*I see females who have a good and prestigious job in Computer Science fields*" (Participant S3 (M)).

"*In Saudi Arabia, we do not have a difference between boys and girls to study Computer Science, but I read an article talked about female underrepresentation in Computer Science around the world, but I'm not sure if that is true*" (Participant S11 (F)).

However, some of the participants in Scotland mentioned that other majors were considered male-dominated besides the Computer Science major. The following interview excerpts show this:

"*I guess Computer Science is sometimes lumped in with Physics, which is mostly male-dominated*" (Participant P15 (F)).

"*I think being a STEM field, it is very male-dominated. And I think there should be a lot more encouragement for females to be able to pursue a role like this. It should be made more accessible for girls rather than just being given the image it's just a boys' subject*" (Participant P16 (F)).

"*I think that's the way all over the world. It's called STEM subjects. Historically and now male-dominated even though it has been slowly attracting more women*" (Participant P17 (M)).

One participant in Scotland identified the role of the media with regard to considering a Computer Science major male-dominated; she said:

"*I think just media and marketing, just having a very even spread and just not discriminating over gender whatsoever. Which is a bit tricky, because obviously in a male dominated field, there are just going to be more men to take photos of*" (Participant P7 (F)).

4.7.1 Characteristics of Computer Science Students

There was a range of positive and negative words used by the participants in both contexts about the characteristics of Computer Science students, such as nerdy and smart. Most of the participants used different phrases to indicate "non-social", as in the following interview excerpts:

"*People who don't really go out and talk much, and just stay inside their houses or their labs and stare at their computer screens and aren't really sociable*" (Participant P13 (F)).

"*Socially not very adept*" (Participant P2 (F)).

"*Non-social, isolated people, they do not like to work with a group*" (Participant S9 (F)).

Some of the participants used the word "nerdy"; for example:

"*I think they think they're quite nerdy, introverted*" (Participant P5 (F)).

"Nerdy and stay with computers 24 hours" (Participant S4 (F)).

Some of the participants in Scotland mentioned "mostly male" as a characteristic of Computer Science students; for example:

"*I think most people would automatically think it has to be a man. Even though there are girls*" (Participant P1 (F)).

"*If you have long hair and you are male, you are probably into computing*" (Participant P4 (M)).

A few of the participants suggested other characteristics of Computer Science students, such as:

"*Playing lots of video games*" (Participant P11 (F)).

"*Eating unhealthy things*" (Participant P17 (M)).

"*Wearing glasses*" (Participant S1 (M)).

However, there were some positive words that participants associated with the characteristics of Computer Science students. For example,

"*I just see them as very smart and sort of like wealthy people, because obviously they will be paid well*" (Participant P2 (F)).

"*Very analytical and over-achievers*" (Participant P16 (F)).

“*Critical thinking*” (Participant S10 (F)).

“*Smart*” (Participant S6 (F)).

“*Excellent students; they study a lot*” (Participant S8 (F)).

To sum up, according to the participants’ responses, the perceptions of the Computer Science major differed between the two contexts, Scotland and Saudi Arabia. Society's perception in Saudi Arabia seems to be positive, while in Scotland, some participants mentioned the stereotypes and society’s bias against females in the Computer Science major. Regarding the family’s perceptions and getting support to study Computer Science, some participants in Scotland noted a difference between females and males. Still, in Saudi Arabia, some participants mentioned that there was a difference in other majors like medicine, but not in Computer Science. Also, the participants in Saudi Arabia did not consider Computer Science a male-dominated major as there are a lot of female students in Computer Science. In contrast, in Scotland the Computer Science major is considered male-dominated, as mentioned by some of the participants there. The characteristics attributed to Computer Science students, as noted by participants in both contexts, were similar, such as smart, nerdy, and non-social. The main difference was that Computer Science is a male-dominated subject in Scotland but not in Saudi Arabia.

4.8 Suggestions

Some Suggestions arose based on the participants’ responses about female underrepresentation in Computer Science and how to attract more students, particularly females, to the Computer Science major. These suggestions from the participants, either for schools or for universities, are not considered influenced factors.

For School:

Participants offered some suggestions to schools, especially with regard to supporting and preparing students at school to choose or think about Computer Science as a potential major at university. These suggestions included: making computing subjects at school more practical and more important. Also, presenting more visits, talks, and events at school about Computer Science. Most of the following interview excerpts give answers to the question: How can schools support students to study Computer Science as a major at university?

Some of the participants in both contexts, Scotland and Saudi Arabia, mentioned the computing curriculum and making it more practical, as in the following examples:

"*I think they need to make it more practical, have more coding, rather than a textbook which tells you the file size of a picture. Just maybe to say that schools definitely need to show students that Computer Science is more than just what you learn at school*" (Participant P10 (F)).

"*I hope that the decision-makers add some significant concepts and skills related to computing at school curricula so that the students might know more about the nature of Computer Science major before university*" (Participant S6 (F)).

Another suggestion was related to making Computing at school more essential and in fact compulsory. This emerged from the participants in Scotland only, because the computing subject at Saudi schools is already compulsory. The following interview excerpts give ideas on how to make the computing subject more important:

"*I would probably say, encourage people to take it at Standard Grade at least. Because for us, it was not compulsory. Our Standard Grades were completely optional, whatever you wanted to choose. And I think I did not realize when I was that age, I did not realize the importance of computers. I think they should emphasize it more. And at least have an option and mention that you should really take it*" (Participant P15 (F)).

"*I think they should make it more of an option in schools*" (Participant P14 (M)).

Another suggestion for schools, as some of the participants mentioned, is that early exposure to Computer Science may help to attract more students. For example:

"*I think that making computing more accessible to students of a young age could be one way, since it would prevent early age judgement from different sexes to other sexes*" (Participant P4 (M)).

"*You need to hit people at the primary school level. That's the key to getting people*" (Participant P3 (M)).

One participant reported her experience as follows:

"*I think it's important to start introducing the students to programming and technology at an early age. In my case I was never introduced to it, so I did not ... in a sense I did not even know it existed, or that it could be something for me until I came to university*" (Participant P11 (F)).

Some participants suggested more events, talks, and visits for students in schools about Computer Science, such as:

"*Additional activities in Computer Science may help and prepare the students for the university*" (Participant S7 (F)).

"*I think if school encouraged more maybe internships or more workplace visits, or even just more information sessions from the university, it would help people be like okay, I want to pick this*" (Participant P1 (F)).

The following are two examples of visits by Computer Science university students to schools:

"*Send girls who are doing Computer Science. Inspiring girls. So, let the little girls want to be the big, cool girls who study Computer Science. I'm going to say the same about female Computer Science teachers, because that worked very well for me*" (Participant P2 (F)).

"*Some people from the university came to my school to get talks about Computer Science. They were telling people what their project was for the last year and showing them how they built it. And I thought it was quite interesting, and other people as well thought that it is something they would like to do*" (Participant P8 (F)).

In addition, a few of the participants mentioned competitions for students; for example:

"*I think there should be more Computer Science-related fun events. If we could have Computer Science exhibitions held by schools. And competitions. Not that competitive,* *but something that students would participate in I think it could encourage more and more students to take it up*" (Participant P13 (F)).

"*Schools can offer programming courses and competitions to the students*" (Participant S4 (F)).

For the Universities:

Other suggestions were for universities to attract more females into a Computer Science major. The majority of the participants in Scotland only suggested more visits and talks to schools from females in computer science, as role models; more promotion and advertising of the computer science major, such as an open day or scholarships for females only. Most of the following interview excerpts express an answer to the question: How can universities attract more females to study Computer Science?

Some of the participants suggested school visits and making more females in Computer Science visible, as in the following examples:

"*Because there are women in Computer Science. So, I think it is important to give them more visibility, because that might give other girls encouragement to go into it. Visit schools and promote Computer Science, but girls to promote that in high schools, so girls in high school can see that*" (Participant P11 (F)).

"*I suppose there could be more female role models in Computing Science. I guess that's kind of missing, because most people you see who you generally associate with being good at Computer Science are male. So maybe that's a problem that could be addressed*" (Participant P15 (F)).

More promotion and marketing of the Computer Science major was mentioned by some participants. For example:

"*I think universities just need to actually promote the actual image of Computer Science. Like they do not actually say much about what you are actually going to be doing. It just tells you on the website, it just has the subject you're going to be learning*" (Participant P10 (F)).

"*I think the way they market the degree; I don't really think Computer Science is really well pushed. I think they tend to push the more popular subjects which doesn't make any sense, because they're already popular*" (Participant P16 (F)).

A participant talked about her experience and how an open day helped her to choose the Computer Science major:

"*I think the open day really, really helped me see what I wanted to do, so I think that's what made me want to study it, just because the lecturer was so enthusiastic about it as well*" (Participant P8, (F)).

Other suggestions included making some promotional events female only:

"*Perhaps having special female-specific events, like having a women-only open day or something like that, to kind of encourage more girls who might be unsure about whether it's a good idea for them to go into Computing because of the fact they consider it male-dominated*" (Participant P6 (M)).

"*Maybe organizing events that are directed for women to show them around, where they can feel more confident, than if it is a general event for men in Computer Science,* *then the women may not feel that welcome. So maybe that could be one of the options*" (Participant P12 (F)).

Regarding a specific event for females only, as mentioned above, one participant offered another opinion, saying:

"*Because obviously there's programs and scholarships they can do. But that could be just discriminating against men who are really good at it*" (Participant P5 (F)).

To conclude, the suggestions for schools which were mentioned by the participants in both contexts were similar, mainly to make the Computing subject more practical, with more programming. Making the Computing subject compulsory was mentioned by participants in Scotland only, as it is already compulsory in Saudi Arabia. Suggestions made in Scotland to increase female representation included: more visits and talks to the schools from female role models in Computer Science, and more promotion and advertising for Computer Science, such as open days particularly targeted at females.

4.9 Chapter Summary

The chapter presented these findings of data collected by the qualitative approach, using semi-structured interviews. The data analysis shows the role of prior experience, social support, self-efficacy, and outcome expectations in influencing the participants to choose to study a Computer Science major. It also presented the categories of perceptions of Computer Science and suggestions for schools and universities in relation to the Computer Science major, as they emerged from participants' responses.

In terms of Prior Experience all participants in Saudi Arabia had compulsory experience from school but it was mainly in terms of applications, while the experience in Scotland was more varied, with some students having a significant amount of programming. Some of the participants in both settings had influential experiences outside of school. The experience was male-dominated in Scotland but mixed in Saudi Arabia. Some participants in both contexts described Computing at schools as fun, but some in Saudi Arabia said it was boring. Overall, it seems that Computing at school did not have a strong influence on the choice of Computer Science at university by participants.

Social Support did appear to exert a strong influence on participants in both contexts to choose to study Computer Science. This support was mainly from family members, but teachers and friends were also mentioned in Scotland.

Self-efficacy appeared to be another important factor in both contexts, with participants mentioning enjoyment in creating new things and problem-solving. Some participants in Scotland mentioned their skills in Maths and programming. Some females in Scotland expressed a lack of confidence in their ability to study Computer Science.

Outcome Expectation was another strong factor for participants in both contexts, highlighting the prospects of good pay and the range of career options available with a Computer Science degree.

In terms of the created theme of Perceptions, there was a striking difference between the two contexts. A career in Computer Science is viewed positively in Saudi Arabia whereas in Scotland the views were more mixed, particularly with regard to females, with Computer Science often being viewed as male-dominated in this context.

In terms of the Suggestions, participants in both contexts suggested making the subjects at school more practical, for example by including more programming. Participants from Scotland suggested that Computing subject might be made compulsory at school and, in terms of improving female participation, it was suggested there could be more school talks from female role models and female-only open days.

The following chapter will present the findings of the second phase of this study, a survey designed to validate and generalize these findings.

Chapter 5: Quantitative Findings

5.1 Introduction

This research aims to investigate the factors that influenced the students (males and females) to choose to study a Computer Science major at university in two different contexts, Scotland and Saudi Arabia. This chapter presents the statistical analysis of data collected by the quantitative approach and is based on a questionnaire. As described in the Methodology chapter, the questionnaire was designed based on feedback and analysis of the qualitative data from the interview study. The chapter includes descriptive statistics of the sample demographic, descriptive statistics of the data, the Kruskal-Wallis test for significant differences between male and female responses, quotations from the open-ended questions, and the chapter summary.

5.2 Demographic and Response Rate

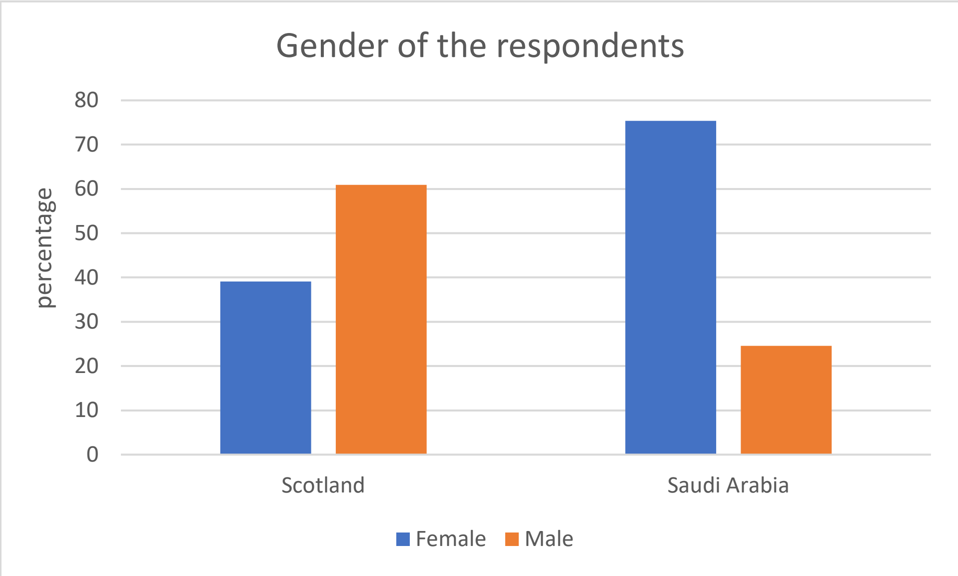

Figure 5-1 The gender of participants in Scotland and Saudi Arabia

There were 308 responses from Scotland and 684 responses from Saudi Arabia: 192 completed responses in Scotland and 341 completed responses in Saudi Arabia. The incomplete responses were eliminated from the analysis. The respondents comprised 117 males (60.9%) and 75 females (39.1%) from Scottish universities, and 84 males (24.6%) and 257 females (75.4%) from Saudi universities; see Figure 1. The female response rate is high in Saudi Arabia due to the large number of females majoring in Computer Science field. In contrast, Scotland has female underrepresentation in Computer Science major.

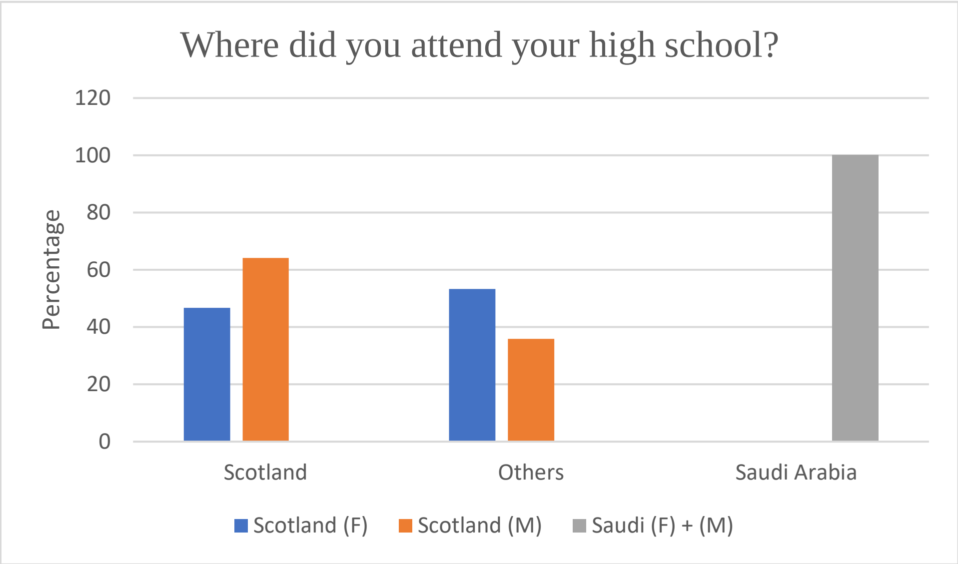

Figure 5-2 Where the respondents attended high school

As shown in Figure 2, all the respondents in Saudi Arabia attended high school in that country; in Scotland, 64.1% of the male respondents and 46.7% of the female respondents attended high school there, while 53.3% of the female respondents and 35.9% of the male respondents attended high school in other contexts.

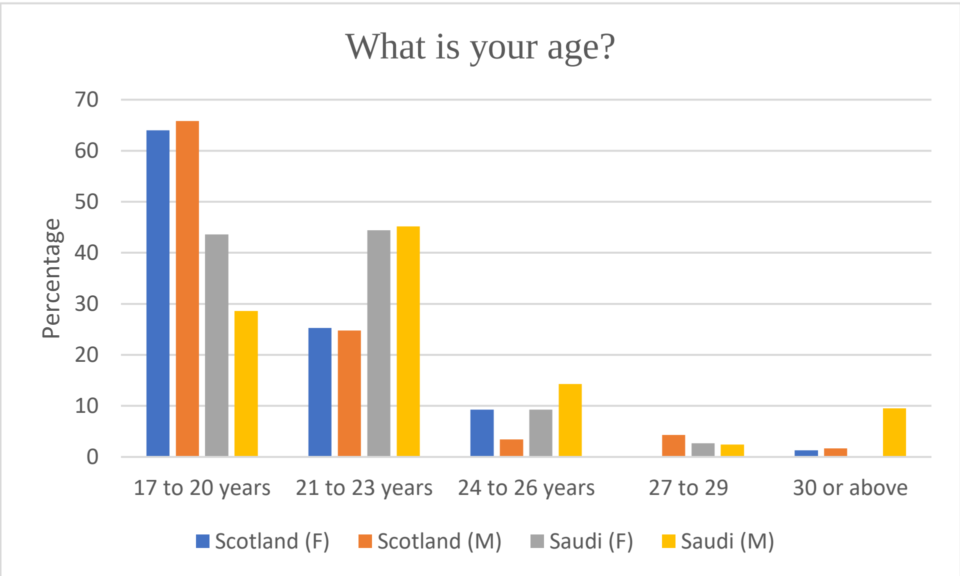

Figure 5-3 The age of respondents

The age of the respondents is shown in Figure 3, according to which 64% of the female respondents and 65.8% of the male respondents in Scotland, and 43.6% of female respondents and 28.6% of male respondents in Saudi Arabia were aged 17 to 20. Some of the respondents in Scotland (25.3% females, 24.8% males) and in Saudi Arabia (44.4% females, 45.2% males) were aged 21 to 23. The remaining respondents were 24 or older as shown in Figure 3.

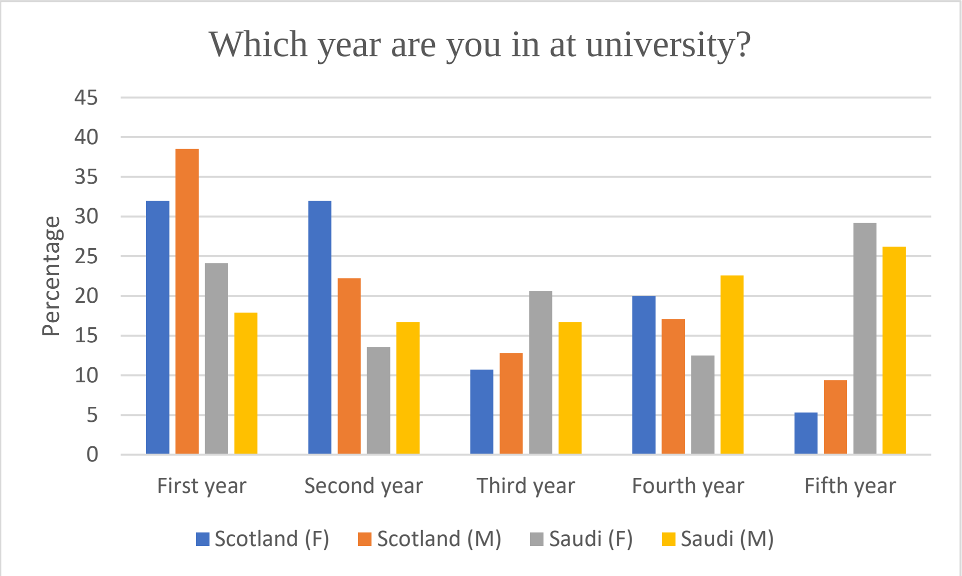

Figure 5-4 Respondents' year at university

Figure 4 presents the respondents' year at university. Some of the respondents in in Scotland (32% females, 38.5% males) and in Saudi Arabia (24.1% females, 17.9% males), were in first year. The percentage of respondents who were studying in second year was 32% females and 22.2% males in Scotland, and 13.6% females and 16.7% males in Saudi Arabia. Some of the respondents in Scotland (10.7% females, 12.8% males) and in Saudi Arabia (20.6% females, 16.7% males) were in third year. The percentage of respondents who were studying in fourth year was 20% females and 17.1% males in Scotland, and 12.5% females and 22.6% males in Saudi Arabia. Only a few of the respondents in Scotland (5.3% females, 9.4% males), but more respondents in Saudi Arabia (29.2% females, 26.2% males), were in fifth year.

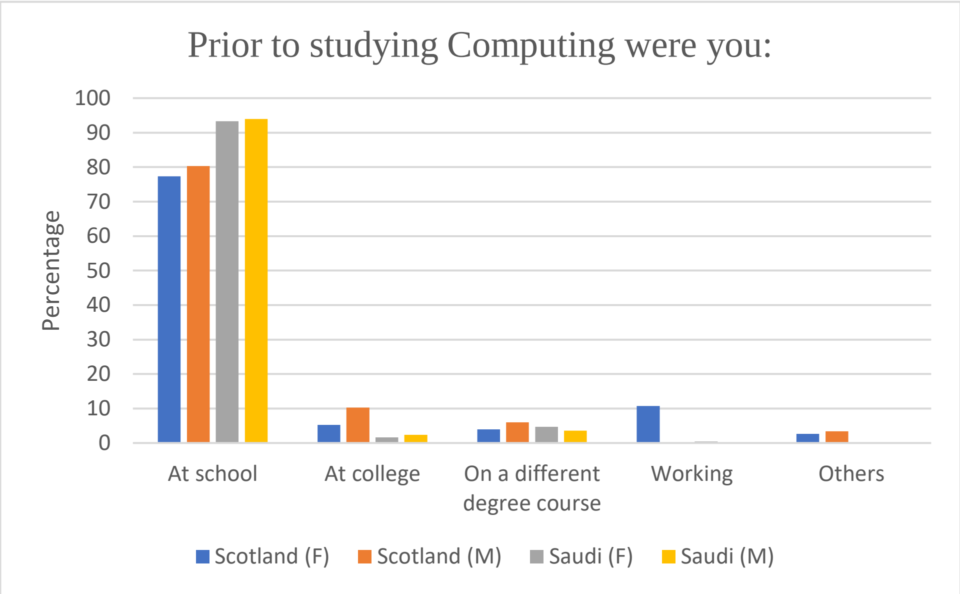

Figure 5-5 What respondents did prior to coming to university

Before studying a Computer Science major at the university, most of the respondents in Scotland (77.3% females, 80.3% males) and in Saudi Arabia (93.3% females, 94% males) were at school, while a few of the respondents in both contexts indicated other choices, as shown in Figure 5. In Scotland only, 2.7% of female respondents and 3.4% of male respondents gave other answers. They added: at home, gap year, travelling and unemployed.

To sum up, most of the respondents in both contexts were at school prior to studying Computer Science at university.

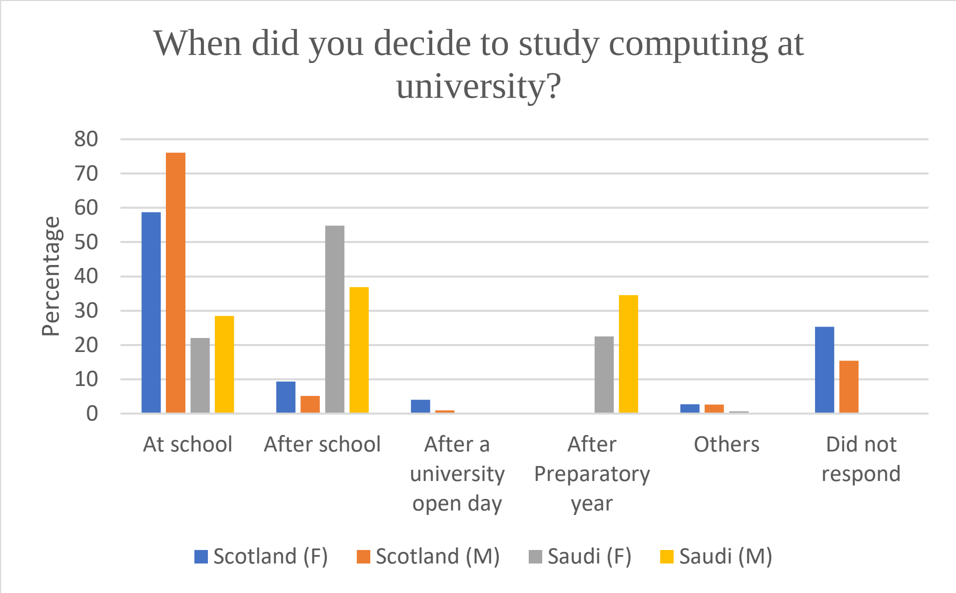

Figure 5-6 When respondents decided to study computing at university

Most of the respondents in Scotland (58.7% females, 76.1% males), and some of the respondents in Saudi Arabia (22% females, 28.5% males), decided to study Computer Science at university when they were at school, while a few of the respondents in Scotland (9.3% females, 5.1% males), and number of them in Saudi Arabia (54.8% females, 36.9% males) made the decision after school. The decision to study the Computer Science major after the preparatory year was made by some of the respondents in Saudi Arabia (22.5% females, 34.5% males) only. Also, the choice was made after a university open day by a few of the respondents in Scotland (4% females, 0.9% males), and a few of the respondents in Scotland (2.7% females, 2.6% males) said they were on a different major, but then decided to change to a Computer Science major. As this was an optional question some of the respondents in Scotland (25.3% females, 15.4% males) did not respond.

The decision to study Computer Science at university was made by most of the respondents in Scotland at school, whereas in Saudi Arabia it was made after school.

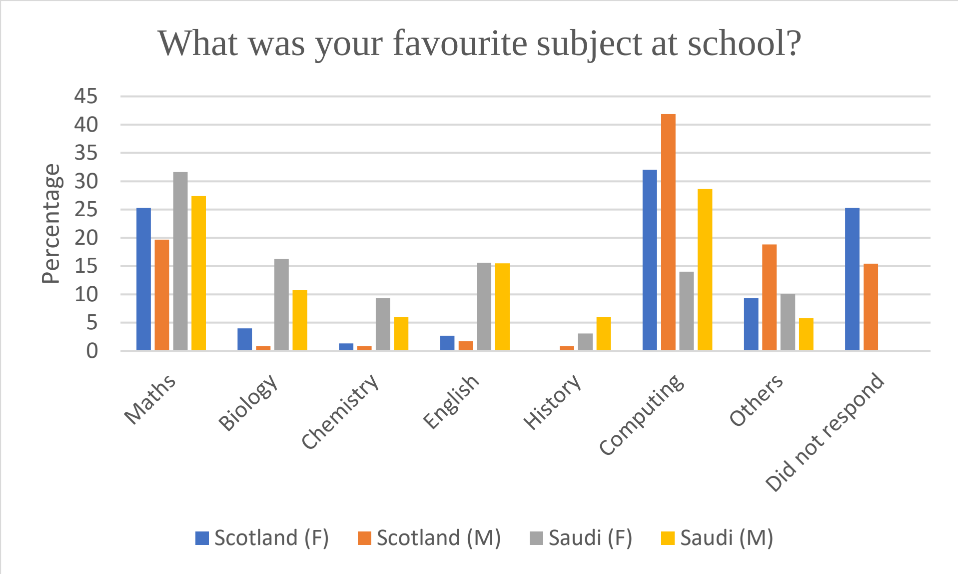

Figure 5-7 Respondents' favourite subject at school

The data in Figure 7 show that Computing was the favourite subject at school for most respondents in Scotland (32% females, 41.9% males) and for most males in Saudi Arabia (28.6%) but only for some females (14%) in Saudi Arabia. This was followed by Maths in Scotland (25.3% females, 19.7% males) and in Saudi Arabia (31.6% females, 27.4% males). A few of the respondents selected different subjects listed in the choices, as follows:

For Biology in Scotland 4% females, 0.9% males, and in Saudi Arabia 16.3% females, 10.7% males.

For Chemistry in Scotland 1.3% females, 0.9% males, and in Saudi Arabia 9.3% females, 6% males.

For English in Scotland 2.7% females, 1.7% males, and in Saudi Arabia 15.6% females, 15.5% males.

For History in Scotland 0.9% males, and in Saudi Arabia 3.1% females, 6% males.

The respondents were given the opportunity to add any other subjects. So, some of the respondents in Scotland (9.3% females, 18.8% males) and in Saudi Arabia (10.1% females, 5.8% males) made this choice, adding other subjects such as Physics, Music, PE, and Design. Some clarified that they did not have any particular favourite subjects. As this was an optional question, some of the respondents in Scotland (25.3% females, 15.4% males) did not answer.

Therefore, the favourite subject at school for most of the respondents in both contexts was either Computing or Maths.

5.3 Analysis of the Questionnaire

The questionnaire contained five sections, which included items that influenced the students to choose to study Computer Science at university, namely the four SCCT factors: prior experience, social support, self-efficacy, and outcome expectations, plus the additional factor of perceptions surrounding a Computer Science major. In addition, there were four optional open-ended questions at the end of the questionnaire, on suggested factors that could attract or deflect males and females towards or away from a Computer Science major. Descriptive statistics, and the Kruskal-Wallis test was used to analyse and present the data, as described in the Methodology chapter, section 3.4.3. The following sections show the results of the questionnaire in the two contexts, Scotland and Saudi Arabia.

5.4 Prior Experience

The prior experience section of the questionnaire included questions about the respondents' experience of Computing at school, and about informal learning outside of school. A question at the beginning of the prior experience section asked the respondents whether they had studied a Computing subject at school. Some of the respondents in Scotland only (22.7% females, 15.4% males) had not studied a Computing subject at school. Either they did not choose it (10.7% females, 9.4% males) or there was no Computing subject in their school (12% females, 6% males), as shown in Figure 8. These respondents therefore did not complete the questions about Computing at school. In contrast, all the respondents in Saudi Arabia studied Computing at school.

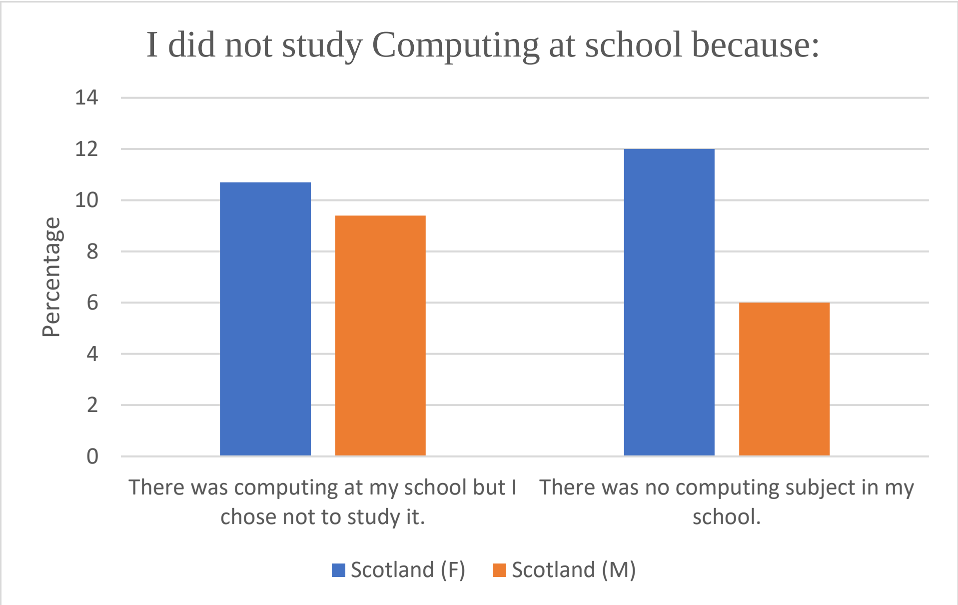

Figure 5-8 Why the participants did not study a Computing subject in school

5.4.1 Computing at School

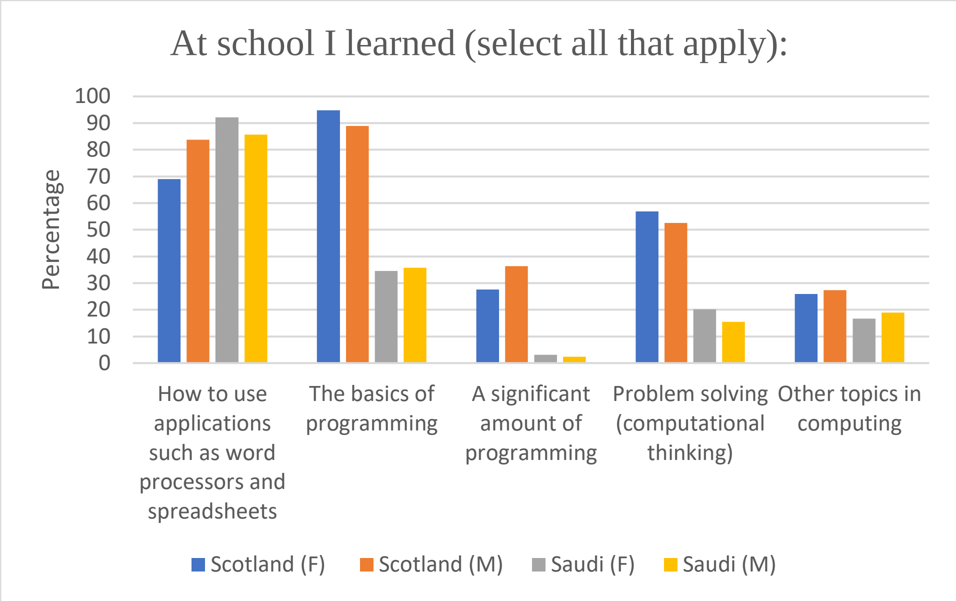

Figure 5-9 Computing topics taught at school

The computing topics that were taught at school are shown in Figure 9 for both contexts. In Scotland only, 22.7% females and 15.4% males did not respond to this question because they did not study a Computing subject at school. Most of the respondents who studied Computing at school, in Scotland (69% females, 83.8% males) and in Saudi Arabia (92.2% females, 85.7% males), learned how to use applications such as word processors. Most of the respondents in Scotland (94.8% females, 88.9% males), and some of the respondents in Saudi Arabia (34.6% females, 35.7% males) learned the basics of programming. Some of the respondents in Scotland (27.6% females, 36.4% males) and a few of the respondents in Saudi Arabia (3.1% females, 2.4% males) learned a significant amount of programming at school. Number of the respondents in Scotland (56.9% females, 52.5% males) studied problem solving (computational thinking), whereas in Saudi Arabia only a few of the respondents did (20.2% females, 15.5% males). There were a number of respondents in Scotland

(25.9% females, 27.3% males) and in Saudi Arabia (16.7% females, 19% males) who named some other topics that they studied. Examples of topics reported by the respondents in Scotland are web development and design, database, information systems, computer architecture and components (hardware), law and computer legislation (i.e. Data Protection Act), networking, binary and hexadecimal numbers, principles of internet and technology, and some algorithms and multimedia technology. Also, the respondents in Saudi Arabia reported other topics in computing such as computer components (architecture), operating systems, web design, networking, multimedia, and algorithms.

In summary, according to Figure 9 the topics which were studied in the Computing subject at school differed between the respondents in the two contexts, particularly in the programming aspects. The majority of the respondents in Scotland learned the basics of programming. Moreover, the respondents who learned a significant amount of programming and problem solving in Scotland were more numerous than the respondents from Saudi Arabia. However, the proportion of the responses on learning how to use applications seemed to be a little bit higher in Saudi Arabia than in Scotland.

According to the Kruskal-Wallis test, there was a significant difference ($p < .05$) between males and females in Scotland being taught applications such as Word processors, while in Saudi Arabia, there was no significant difference between males and females. With regard to other choices a Kruskal-Wallis test showed that there was no significant difference between males and females in both contexts, Scotland and Saudi Arabia.

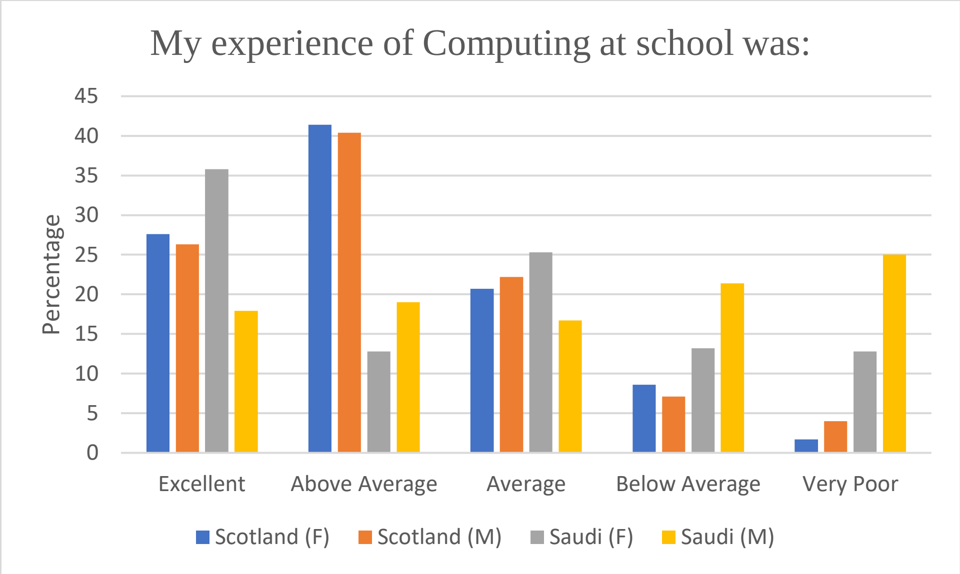

Figure 5-10 The experience of Computing at school

Figure 10 indicates respondents' experience of their Computing subject at school in each context. Some of the respondents in Scotland (27.6% females, 26.3% males) and in Saudi Arabia (35.8% females, 17.9% males) rated their experience as excellent. Most of the respondents rated their experience as average or above average, as follows: in Scotland 41.4% females, 40.4% males and in Saudi Arabia 12.8% females, 19% males said it was above average; while 20.7% females, 22.2% males in Scotland and 25.3% females, 16.7% males in Saudi Arabia rated their experience average. Only a few of the respondents in Scotland (10.3% females, 11.1% males) rated their experience below average or very poor, while some of the respondents in Saudi Arabia (26% females, 46.4% males) also rated it below average or very poor.

Based on the above data, it can be summarized that the experience of Computing at school for both genders in Scotland was mostly above average. While the experience of Computing at school for largely Saudi females was excellent, for Saudi males, the experience was observed evenly spread across all categories.

With regard to the experience of computing at school, the Kruskal-Wallis test indicated that there was no significant difference between males and females in Scotland, while there was a significant difference ($p < .05$) between males and females in Saudi Arabia.

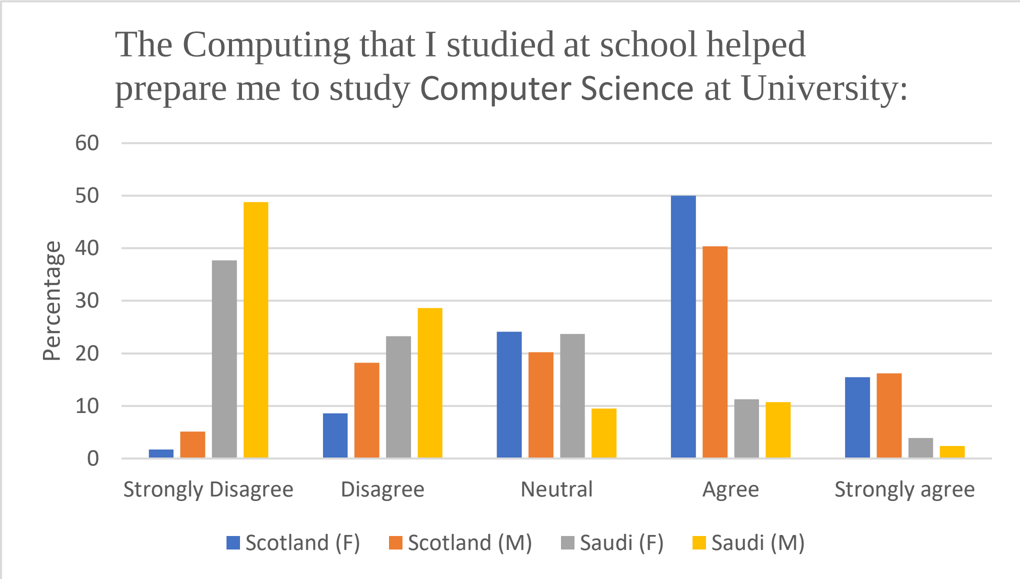

Figure 5-11 Computing at school helped to prepare me to study Computer Science at university

The data in Figure 11 explore whether the Computing subject at school helped and prepared the respondents to study Computer Science at university. Most respondents in Scotland (65.5% females, 56.6% males), and a few in Saudi Arabia (15.2% females, 13.1% males), strongly agreed or agreed that the Computing subject studied at school helped prepare them to study Computer Science at university. But some of the respondents in Scotland (24.1% females, 20.2% males) and in Saudi Arabia (23.7% females, 9.5% males) neither agreed nor disagreed. Some respondents in Scotland (10.3% females, 23.3% males), and most of the respondents in Saudi Arabia (61% females, 77.4% males), disagreed or strongly disagreed.

This suggests that the Computing subjects at school helped prepare most of both genders in Scotland to study Computer Science at university. For most in Saudi Arabia, the Computing subjects at school did not help them. In the Kruskal-Wallis test, there was no significant difference between males and females in Scotland, while there was a significant difference ($p < .05$) between males and females in Saudi Arabia.

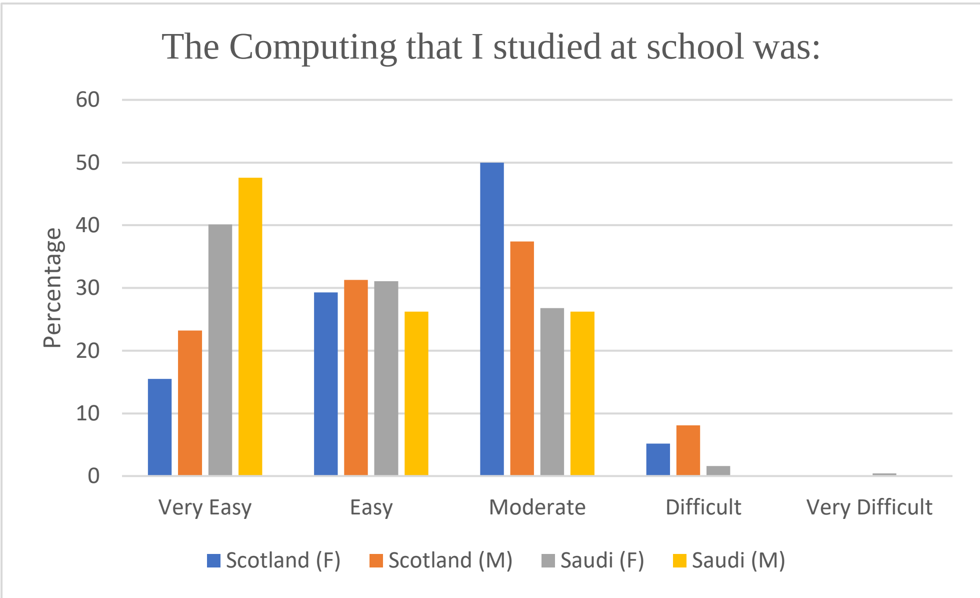

Figure 5-12 Respondents' rating of the Computing subject studied at school

The range of difficulty of the Computing subject studied at school in both contexts is shown in Figure 12. Number of the respondents in both contexts in Scotland (44.8% females, 54.5% males) and in Saudi Arabia (71.2% females, 73.8% males) rated the computing that they studied at school as very easy or easy, while some of the respondents in Scotland (50% females, 37.4% males) and in Saudi Arabia (26.8% females, 26.2% males) considered it moderate. Only a few of the respondents in

Scotland (5.2% females, 8.1% males) and in Saudi Arabia (2% females, 0% males) considered it difficult or very difficult.

This suggests that the level of difficulty of the Computing subject studied at school in both contexts ranged between moderate and easy. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

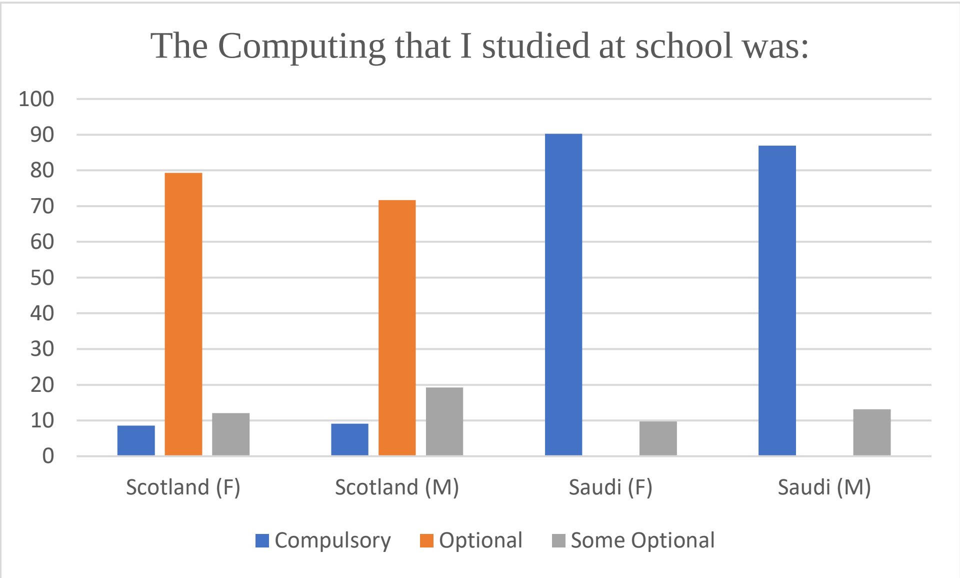

Figure 5-13 Compulsory or optional nature of the Computing subject at school

Figure 13 shows that the Computing subject at school in Scotland (79.3% females, 71.7% males) was mostly optional whereas in Saudi Arabia there was no response for the optional choice. Some of the respondents in Scotland (12.1% females, 19.2% males) and in Saudi Arabia (9.7% females, 13.1% males) had some choice with regard to the computing subject at school. For most of the respondents in Saudi Arabia (90.3% females, 86.9% males), but only a few in Scotland (8.6% females, 9.1% males), it was compulsory.

This implies that the study of Computing at school in Scotland is mostly optional, while it is mostly compulsory in Saudi Arabia. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

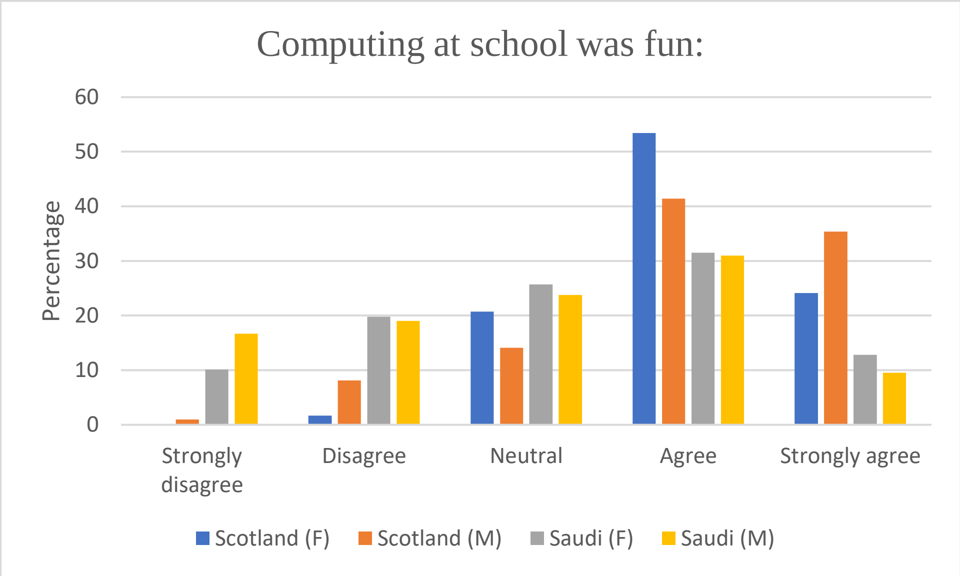

Figure 5-14 Computing at school was fun

As shown in Figure 14, most of the respondents in Scotland (77.5% females, 76.8% males) and some of them in Saudi Arabia (44.3% females, 40.5% males) agreed or strongly agreed that Computing at school was fun, while some of the respondents in Scotland (20.7% females, 14.1% males) and in Saudi Arabia (25.7% females, 23.8% males) neither agreed nor disagreed. Only a few respondents in Scotland (1.7 females, 9.1% males), and some of the respondents in Saudi Arabia (29.9% females, 35.7% males) disagreed or strongly disagreed.

To sum up, the Computing at school was mostly fun in both contexts. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

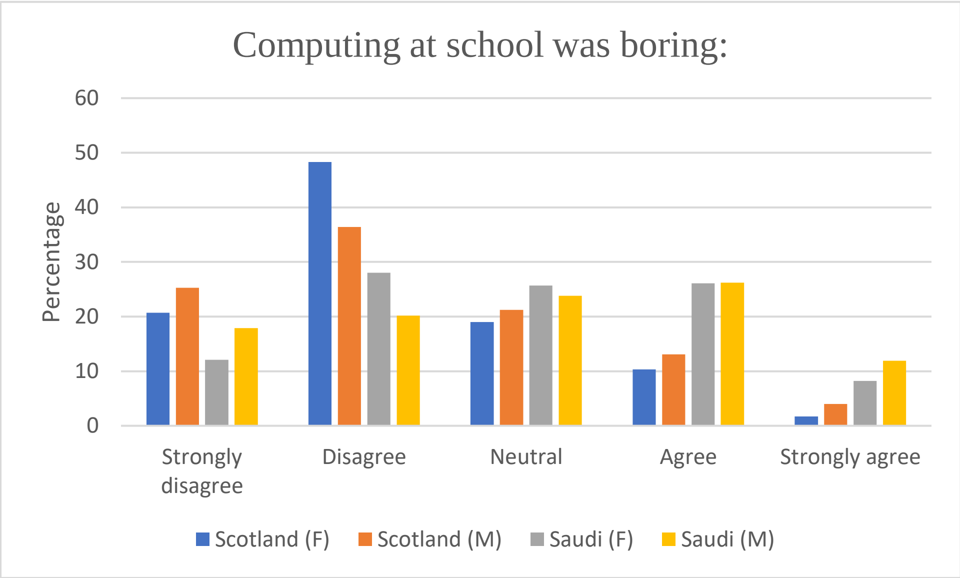

Figure 5-15 Computing at school was boring

Respondents were also asked whether the computing at school was boring. The data in Figure 15 show that most of the respondents in Scotland (69% females, 61.7% males) and some of the respondents in Saudi Arabia (40.1% females, 38.1% males) strongly disagreed or disagreed that this was the case. Some respondents in Scotland (19% females, 21.2% males) and in Saudi Arabia (25.7% females, 23.8% males) neither agreed nor disagreed that Computing at school was boring. But a few of the respondents in Scotland (12% females, 17.1% males) and some in Saudi Arabia (34.3% females, 38.1% males) agreed or strongly agreed.

It is therefore suggested that the Computing at school was not boring for most of the respondents. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

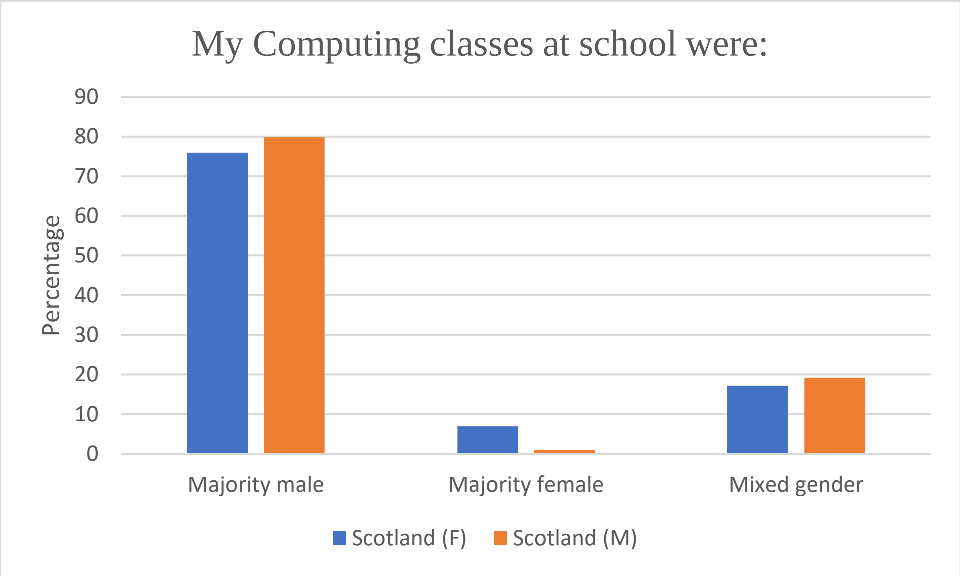

Figure 5-16 The gender of the students in the computing class at school

Figure 16 shows that, in Scotland only, most of those surveyed (75.9% females, 79.8% males) indicated that the majority of students were male, while some (17.2% females and 19.2% males) indicated that the classes were mixed-gender and only a few respondents (6.9% females, 1% males) indicated that the majority were female. This question only applied in the Scottish context because the education system in the Saudi context is single-gender.

Therefore, in Scotland the majority of students at Computing classes at school were male.

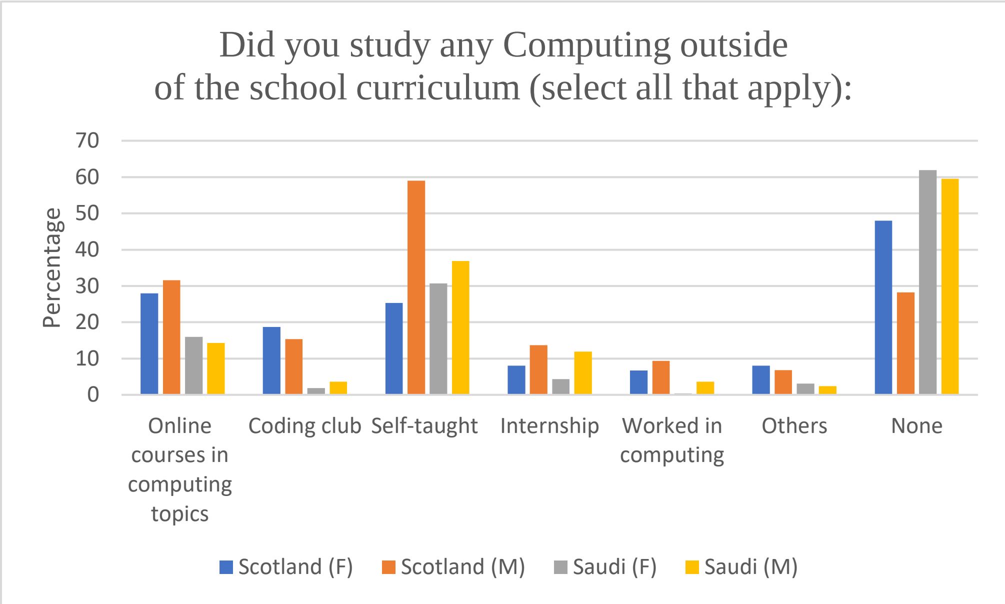

Figure 5-17 Learning computing outside the school curriculum

Figure 17 shows the study of Computing outside the school curriculum in both contexts. Some of the respondents in Scotland (28% females, 31.6% males) and in Saudi Arabia (16% females, 14.3% males) reported the use of online courses. Coding club was mentioned by some of the respondents in Scotland (17.7% females, 15.4% males) but by only a few in Saudi Arabia (1.9% females, 3.6% males). Number of the respondents in Scotland (25.3% females, 59% males) and in Saudi Arabia (30.7% females, 36.9% males) considered themselves self-taught. A few of the respondents in Scotland (8% females, 13.7% males) and in Saudi Arabia (4.3% females, 11.9% males) did an internship; also, a few of the respondents in Scotland (6.7% females, 9.4% males) and in Saudi Arabia (0.4% females, 3.6% males) worked in computing. In addition, a few of the respondents in Scotland (8% females, 6.8% males) and in Saudi Arabia (3.1% females, 2.4% males) selected other options and named some examples, including: summer programs, lessons organized for the national informatics

Olympiad in learning advanced algorithms and data structures, courses in school and learning with family members. However, some of the respondents in Scotland (48% females, 28.2% males) and most respondents in Saudi Arabia (61.9% females, 59.5% males) did not study computing outside the school curriculum.

To sum up, most of the respondents in Saudi Arabia and females in Scotland did not study computing outside the school curriculum, while most of the males in Scotland undertook some self-taught learning.

According to the Kruskal-Wallis test:

- there was no significant difference between males and females in either context for Online courses in Computing and Coding club.
- there was a significant difference ($p < .05$) between males and females in Scotland, while in Saudi Arabia, there was no significant difference between males and females for being Self-taught and no studying outside the school curriculum.
- there was no significant difference between males and females in Scotland, while there was a significant difference ($p < .05$) between males and females in Saudi Arabia for Internship and Worked in computing.

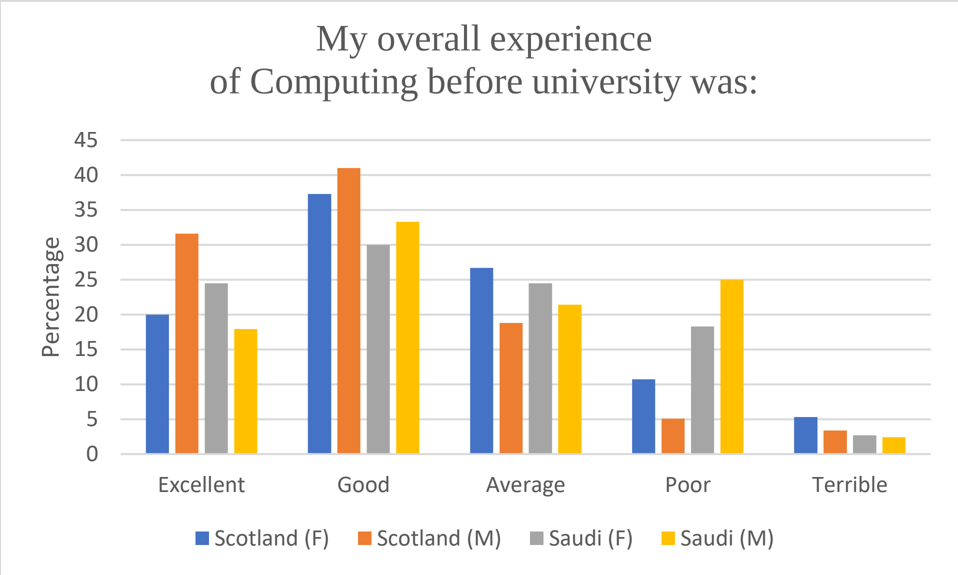

Figure 5-18 Overall computing experience before university

Figure 18 shows the overall experience of the respondents in Computing before university. Most of the respondents in Scotland (64% females, 59.8% males) and in Saudi Arabia (54.5% females, 54.7% males) considered their experience of computing before university either good or average. Number of the respondents in Scotland (20% females, 31.6% males) and in Saudi Arabia (24.5% females,17.9% males) reported their experience as excellent, but a few of the respondents in Scotland (16% females, 8.5% males) and some in Saudi Arabia (21% females, 27.4% males) considered their experience either poor or terrible.

The overall experience of Computing before university for most of respondents in both contexts ranged across average, good, and excellent. However, there were some respondents in the Saudi context and a few in Scotland who had a poor experience. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

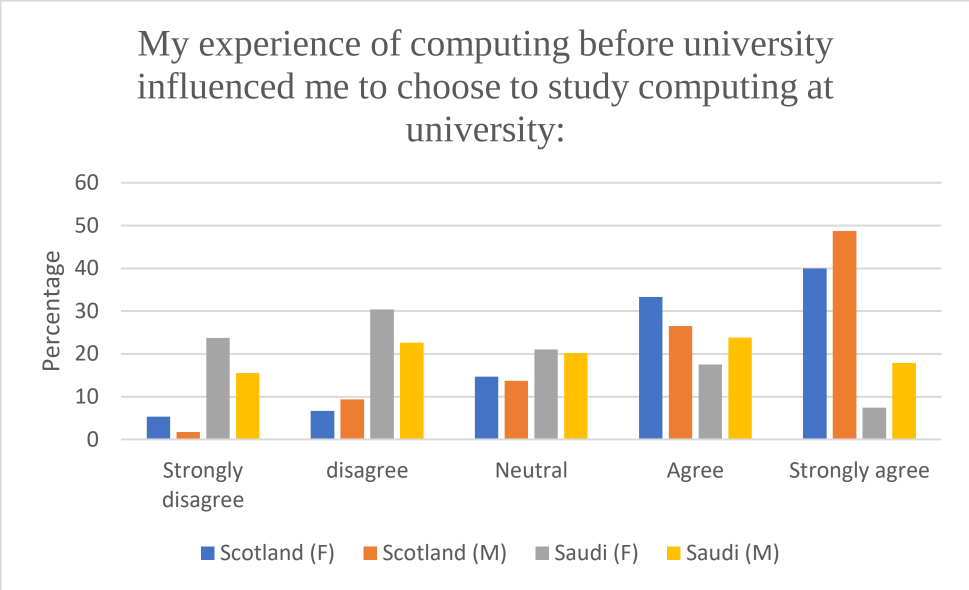

Figure 5-19 The influence of computing experience before university on choosing to study Computer Science

The influence of prior experience of Computing before university on the decision to study Computer Science at university is shown in Figure 19. A few of the respondents in Scotland (12% females, 11.1% males) and some in Saudi Arabia (54.1% females, 38.1% males) strongly disagreed or disagreed that their prior experience in computing influenced them to choose Computer Science at university. Some of the respondents in Scotland (14.7% females, 13.7% males) and in Saudi Arabia (21% females, 20.2% males) neither agreed nor disagreed, while most of the respondents in Scotland (73.3% females, 75.2% males) and some in Saudi Arabia (24.9% females, 41.7% males) agreed or strongly agreed.

Most of those surveyed in Scotland agreed that the experience of computing before university influenced them to choose to study Computer Science at university, whereas this was not the case in the Saudi context. In the Kruskal-Wallis test, there was no significant difference between males and females in Scotland, while there was a significant difference ($p < .05$) between males and females in Saudi Arabia.

5.5 Social Support

Social support is the encouragement that is received from others to choose to study a Computer Science major at university.

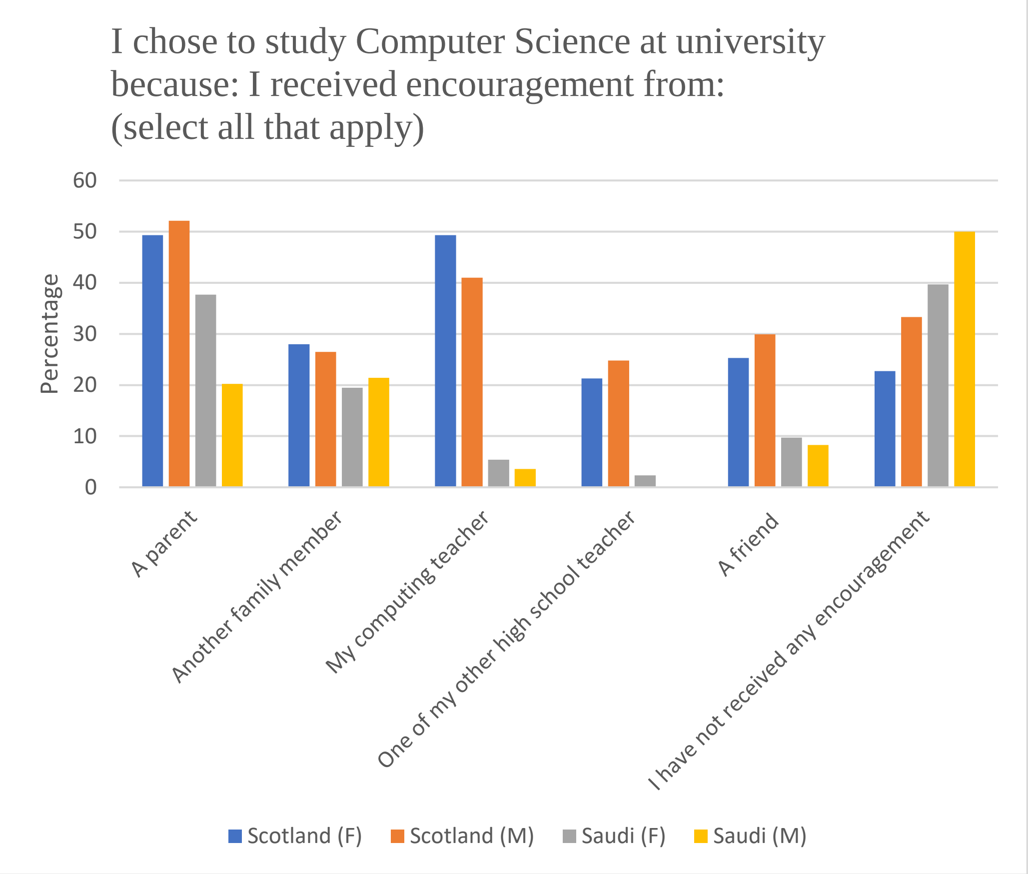

Figure 5-20 Source of encouragement to study Computer Science at university

The support and encouragement that the respondents received from others to choose Computer Science at university is shown in Figure 20. Number of the respondents in Scotland (49.3% female, 52.1% males) and in Saudi Arabia (37.7% females, 20.2% males) received encouragement from a parent. Some respondents in Scotland (28% females, 26.5% males) and in Saudi Arabia (19.5% females, 21.4% males) referred to another family member. Encouragement from either computing teachers or teachers of other subjects in both contexts was as follows: from a Computing teacher in Scotland, reported by 49.3% females, 41% males, and in Saudi Arabia, reported by 5.4% females, 3.6% males; from one of my other high school teachers, reported in Scotland by 21.3% females, 24.8% males, and in Saudi Arabia reported by 2.3% females, 0% males. Some of the respondents in Scotland (25.3% females, 29.9% males) and a few of the respondents in Saudi Arabia (9.7% females, 8.3% males) received encouragement from a friend. Some of the respondents in Scotland (22.7% females, 33.3% males) and in Saudi Arabia (39.7% females, 50% males) indicated that they did not receive any encouragement to study a Computer Science major.

Both genders in Scotland received encouragement from a wide range of sources to study Computer Science. In Saudi Arabia some of the respondents received encouragement from their family, while most of them did not receive any encouragement to study Computer Science at university.

According to the Kruskal-Wallis test, there was no significant difference between males and females in Scotland, while there was a significant difference ($p < .05$) between males and females in Saudi Arabia with regard to having received encouragement from a parent. There was no significant difference between males and females in both contexts, Scotland and Saudi Arabia for all other categories.

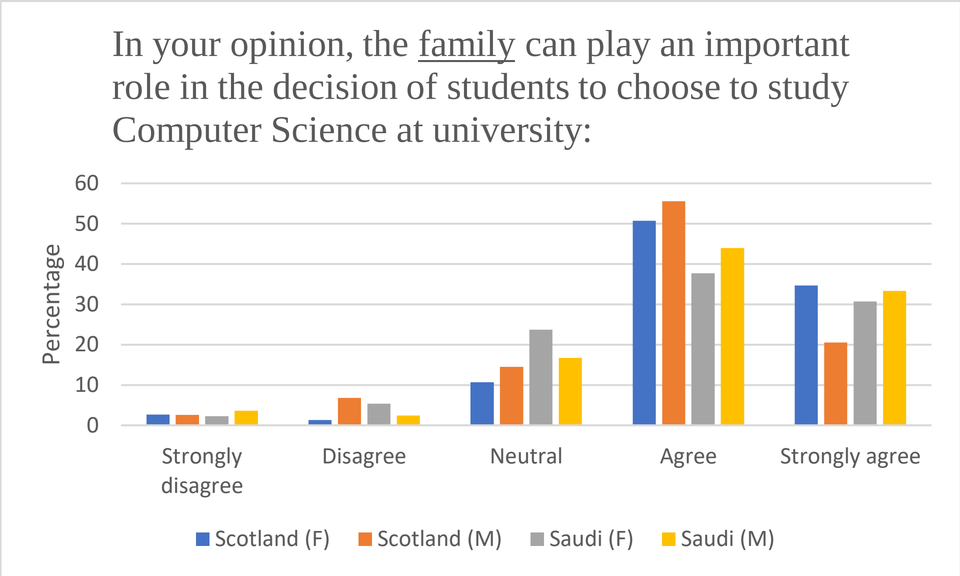

Figure 5-21 Family role in the decision to study Computer Science at university

Figure 21 shows whether the respondents agreed that the family can play an important role in the decision of students to study Computer Science at university. Most of the respondents in Scotland (85.4% females, 76.1% males) and in Saudi Arabia (68.4% females, 77.3% males) agreed or strongly agreed that the family can play an important role in the decision of students to choose to study Computer Science at university. Some of the respondents in Scotland (10.7% females, 15.4% males) and in Saudi Arabia (23.7% females, 16.7% males) neither agreed nor disagreed. Only a few of the respondents in Scotland (4% females, 9.4% males) and in Saudi Arabia (7.7% females, 6% males) disagreed or strongly disagreed.

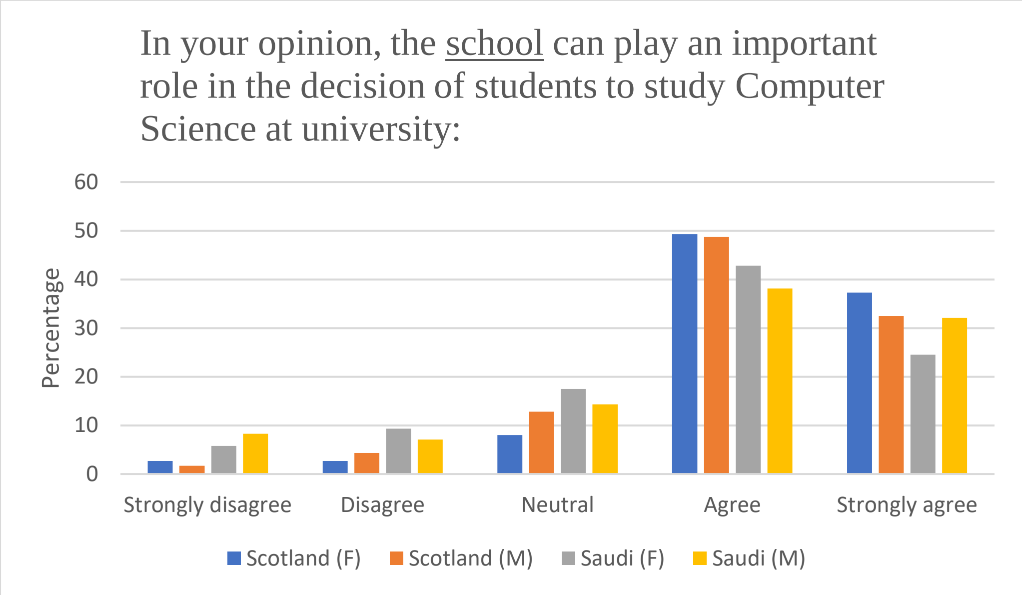

Figure 5-22 School role in the decision to study Computer Science at university

Figure 22 shows the opinion of the respondents regarding the role that the school can play in the decision of students to study Computer Science at university. Most of the respondents in Scotland (86.6% females, 81.2% males) and in Saudi Arabia (67.3% females, 70.2% males) agreed or strongly agreed that the school can play an important role in this decision, while number of the respondents in Scotland (8% females, 12.8% males) and in Saudi Arabia (17.5% females, 14.3% males) neither agreed nor disagreed. A few of the respondents in Scotland (5.4% females, 6% males) and some of them in Saudi Arabia (15.1% females, 15.4% males) disagreed or strongly disagreed.

The data in Figure 21 and Figure 22 suggest that, in both contexts, both the family and the school can play an important role in the decision of students to study Computer Science at university. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context with regard to the importance of the role of family and school.

5.6 Self-efficacy

The self-efficacy questions addressed the respondents' beliefs about their abilities, emotions, and skills before coming to university and the influence of these factors on their decision to study Computer Science.

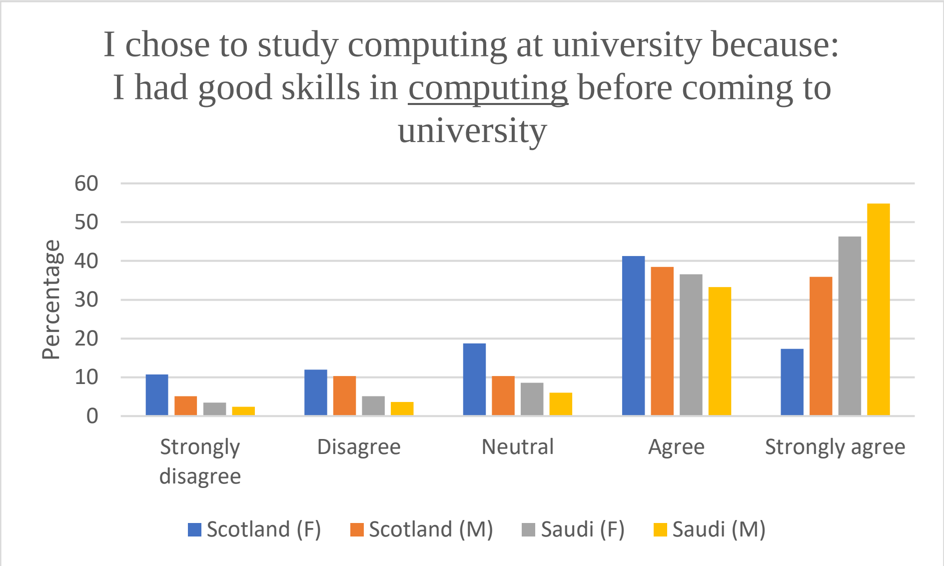

Figure 5-23 Influence of good skills in computing before coming to university

Figure 23 shows the influence that good skills in Computing before university had on the decision to study Computer Science. Most of the respondents in Scotland (58.6% females, 74.4% males) and in Saudi Arabia (82.9% females, 88.1% males) agreed or strongly agreed that good skills in computing before coming to university influenced their choice to study Computer Science. A number of the respondents in Scotland (18.7% females, 10.3% males) and in Saudi Arabia (8.6% females, 6% males) neither agreed nor disagreed. Some of the respondents in Scotland (22.7% females, 15.4% males) and a few of them in Saudi Arabia (8.6% females, 6% males) disagreed or strongly disagreed. According to the Kruskal-Wallis test, there was a significant difference ($p < .05$) between males and females in Scotland, while in Saudi Arabia, there was no significant difference between males and females.

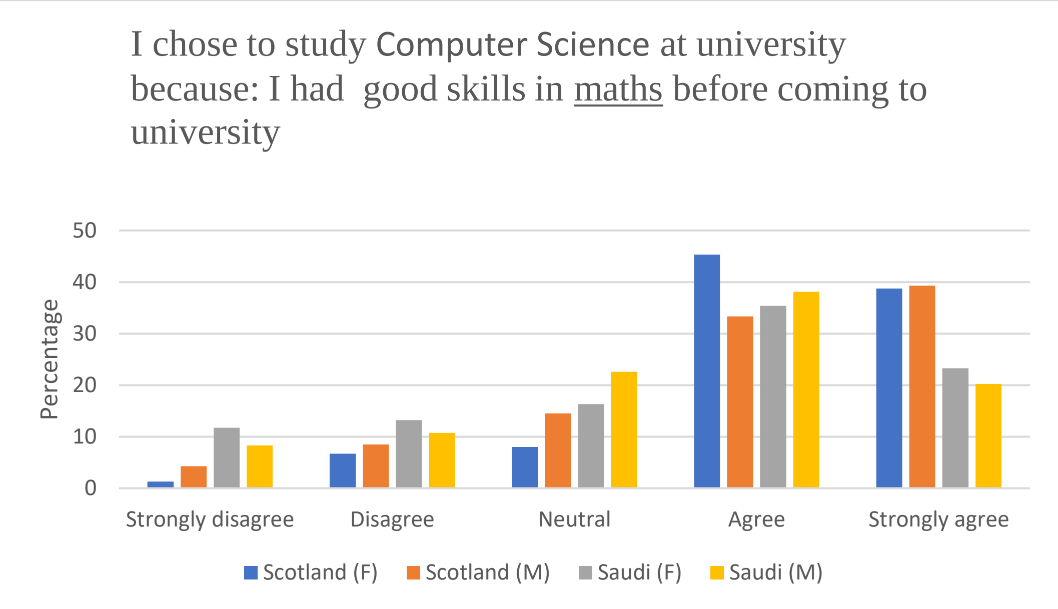

Figure 5-24 Good skills in maths before coming to university

Figure 24 illustrates the skills in Maths that the respondents had before coming to university. In both contexts, most of the respondents in Scotland (84% females, 72.6% males) and in Saudi Arabia (58.7% females, 58.3% males) agreed or strongly agreed that they had good skills in Maths before coming to university. In Scotland 8% females and 14.5% males, and in Saudi Arabia 16.3% females and 22.6% males, neither agreed nor disagreed. A few of the respondents in Scotland (8% females, 12.8% males) and some of them in Saudi Arabia (24.9% females, 19% males) disagreed or strongly disagreed. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

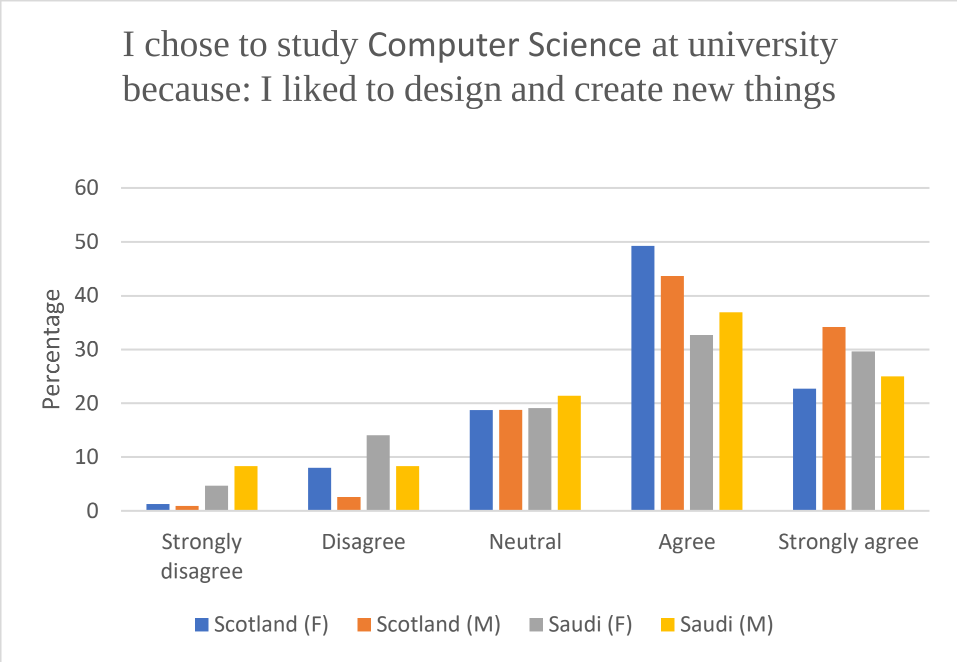

Figure 5-25 Liked to design and create new things

Figure 25 shows that the respondents chose to study Computer Science because they liked to create and design new things. Most of the respondents in Scotland (72% females, 77.8% males) and in Saudi Arabia (62.3% females, 61.9% males) agreed or strongly agreed that they chose to study Computer Science because they liked to create and design new things; while in Scotland 18.7% females and 18.8% males, and in Saudi Arabia 19.1% females and 21.4% males neither agreed nor disagreed. A few of the respondents in Scotland (9.3% females, 3.5% males) and some of them in Saudi Arabia (18.7% females, 16.6% males) disagreed or strongly disagreed. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

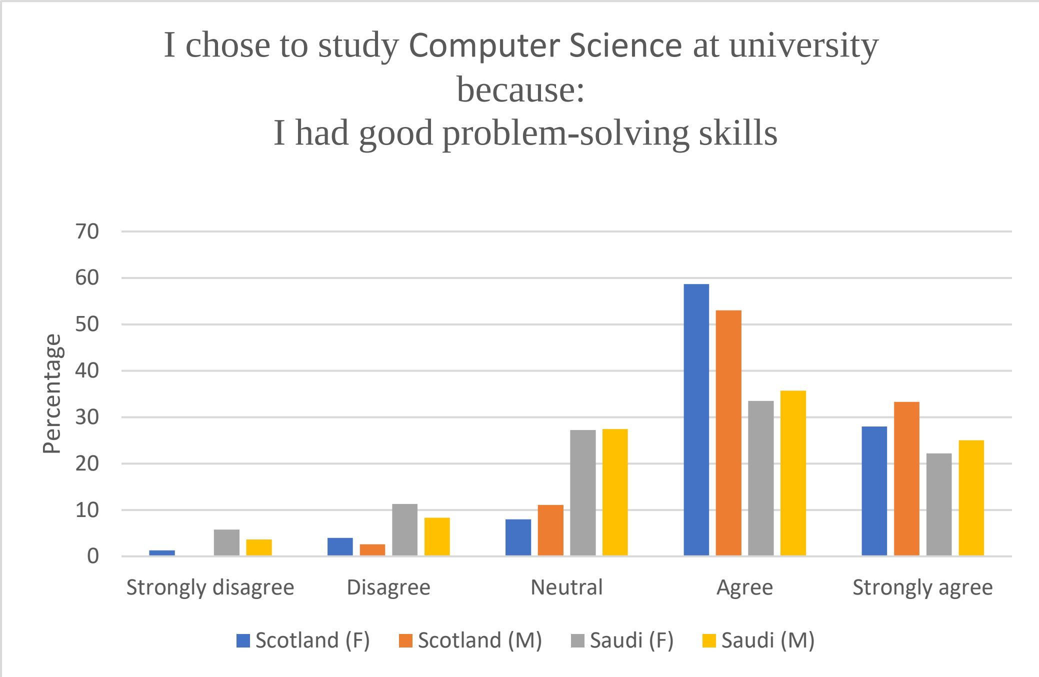

Figure 5-26 Good skills in problem-solving

Figure 26 shows the levels of agreement from respondents on the influence of their problem-solving skills on their choice to study Computer Science. Most of the respondents in Scotland (86.7% females, 86.3% males) and in Saudi Arabia (55.7% females, 60.7% males) agreed or strongly agreed that their good problem-solving skills influenced their choice to study Computer Science. While in Scotland 8% females and 11.1% males, and in Saudi Arabia 27.2% females and 27.4% males, neither agreed nor disagreed. Only a few of the respondents in Scotland (5.3% females, 2.6% males) and some of them in Saudi Arabia (17.1% females, 11.9% males) disagreed or strongly disagreed. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

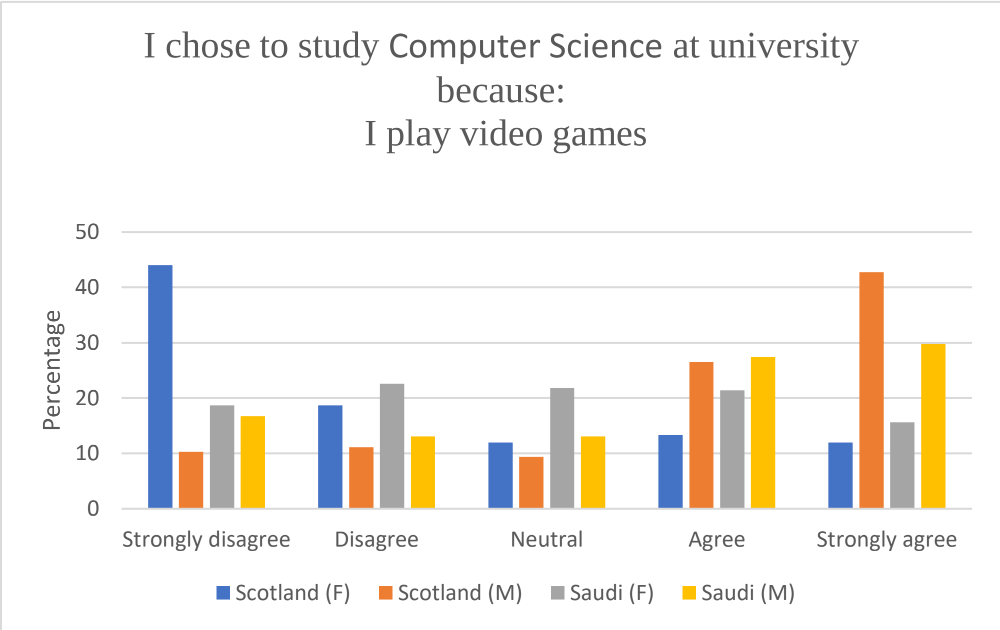

Figure 5-27 Play video games

Figure 27 shows the levels of agreement from respondents on the influence that their playing of video games had on their choice to study Computer Science. In both contexts, most of the male respondents in Scotland (69.2%) and in Saudi Arabia (57.2%) agreed or strongly disagreed that they played video games, and so chose to study Computer Science at the university, whereas some of the female respondents in Scotland (25.3%) and in Saudi Arabia (37%) agreed or strongly disagreed. But 12% females and 9.4% males in Scotland, and 21.8% females and 13.1% males in Saudi Arabia, neither agreed nor disagreed. Moreover, most of the female respondents in Scotland (62.7%), and less than half in Saudi Arabia (41.3%) disagreed or strongly disagreed that they chose to study CS at university because of playing video games. Some of the male respondents in Scotland (21.4%) and Saudi Arabia (29.8%) neither disagreed nor strongly disagreed. In the Kruskal-Wallis test, there was a significant difference ($p < .05$) between males and females in both contexts.

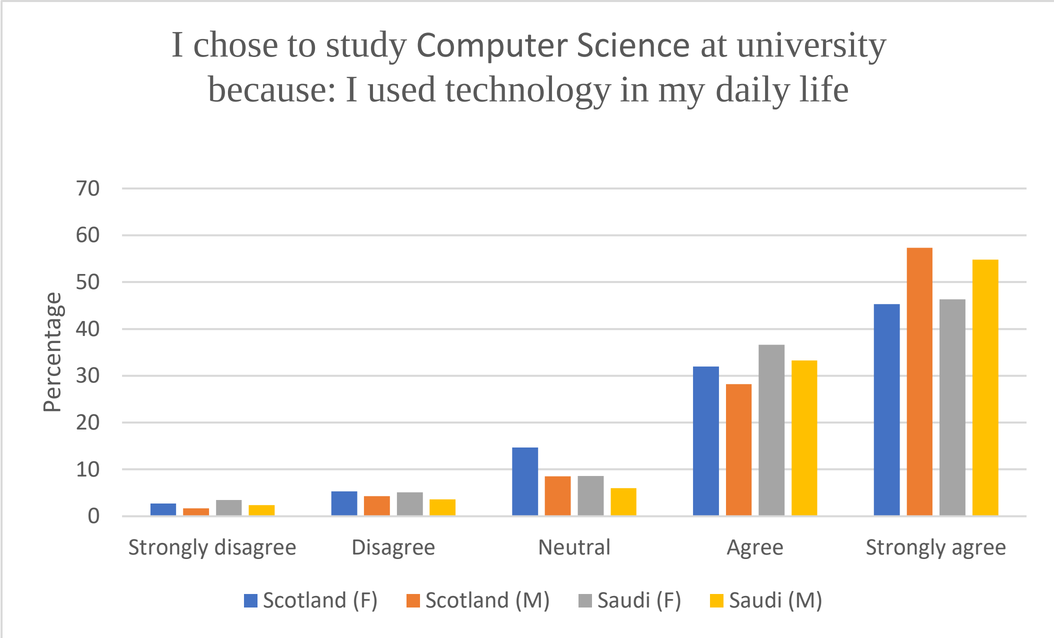

Figure 5-28 Used technology in daily life

Figure 28 shows the levels of agreement from respondents on the influence of technology usage on their choice to study Computer Science. In both contexts, most of the respondents in Scotland (77.3% females, 85.5% males) and in Saudi Arabia (82.9% females, 88.1% males) agreed or strongly agreed that they chose to study Computer Science at university because of using technology in their daily life. But in Scotland 14.7% females and 8.5% males, and in Saudi Arabia 8.6% females and 6% males, neither agreed nor disagreed. Only a few of the respondents in Scotland (8% females, 6% males), and in Saudi Arabia (8.6% females, 6% males) disagreed or strongly disagreed. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

As shown in Figures 23, 24, 25, 26, 27 and 28, the respondents in both contexts seemed motivated to study Computer Science at university by possession of good skills in Computing, Maths and problem-solving, enjoyment of creating and designing new things, playing video games, and the use of technology in their daily life. However, females in both contexts were not motivated by playing video games.

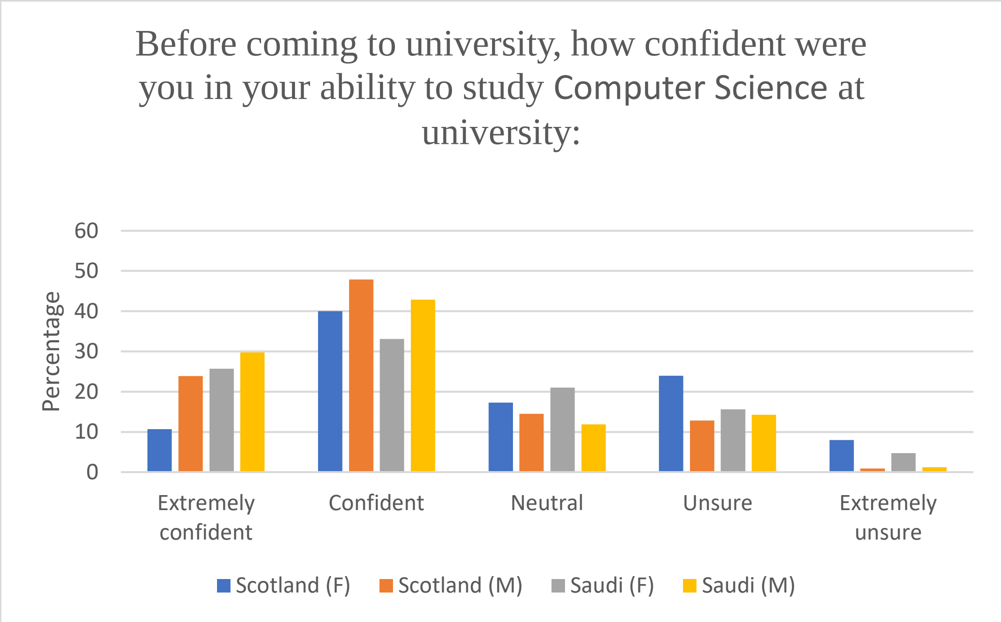

Figure 5-29 Rate of confidence in computing before coming to university

Figure 29 shows the respondents' rating of their confidence in Computing before coming to university. Most of the respondents in both contexts, in Scotland (50.7% females, 71.8% males) and in Saudi Arabia (58.8% females, 72.7% males), were confident or extremely confident in their ability to study CS before coming to the university, whereas in Scotland 17.3% females and 14.5% males, and in Saudi Arabia 21% females and 11.9% males, were neither confident nor unsure. Only a few of the respondents in Scotland (13.7% males) and in Saudi Arabia (20.3% females, 15.5% males) were unsure or extremely unsure, while some of the female respondents in Scotland (32%) were unsure or extremely unsure.

Apart from females in Scotland, the respondents in both contexts were mostly confident in their ability to study Computer Science before coming to university. The

Kruskal-Wallis test indicated that there was a significant difference ($p < .05$) between males and females in Scotland, while in Saudi Arabia, there was no significant difference between males and females.

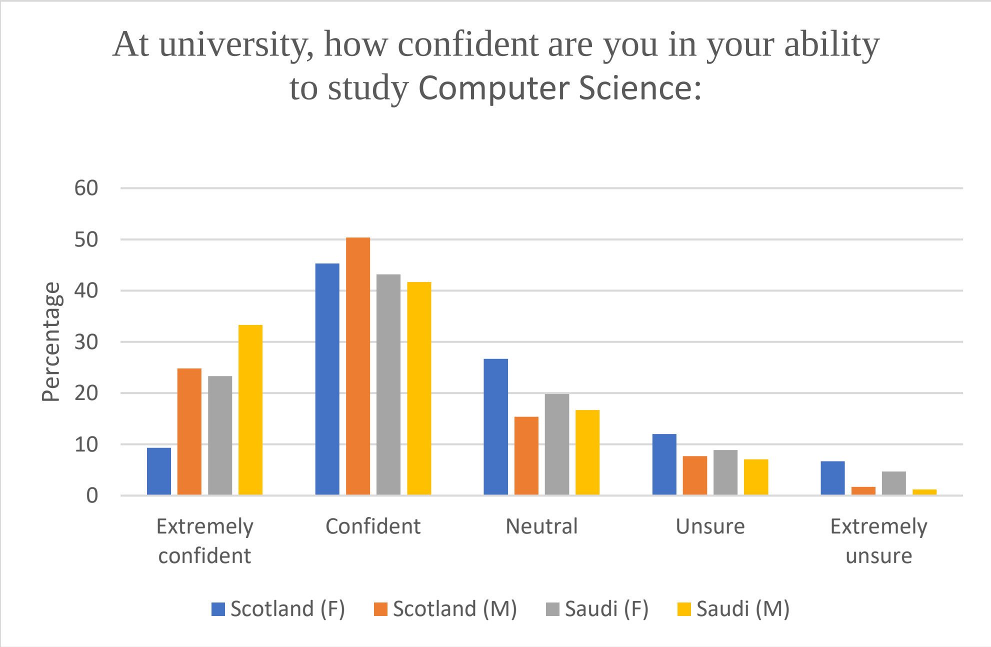

Figure 5-30 Rate of confidence in ability to study Computer Science at university

Figure 30 shows how confident the respondents are in their ability to study Computer Science during their study at the university. Most of the respondents in both contexts, in Scotland (54% females, 75.2% males) and in Saudi Arabia (66.5% females, 75% males), were confident or extremely confident in their ability to study Computer Science, while in Scotland 26.7% females and 15.4% males, and in Saudi Arabia 19.8% females and 16.7% males, were neither confident nor unsure. Some of the respondents in Scotland (18.7% females, 9.4% males) and in Saudi Arabia (13.6% females, 8.3% males) were unsure or extremely unsure.

Most of the respondents in both contexts felt confident in their ability to study Computer Science at university. The Kruskal-Wallis test indicated that there was a significant difference ($p < .05$) between males and females in both contexts.

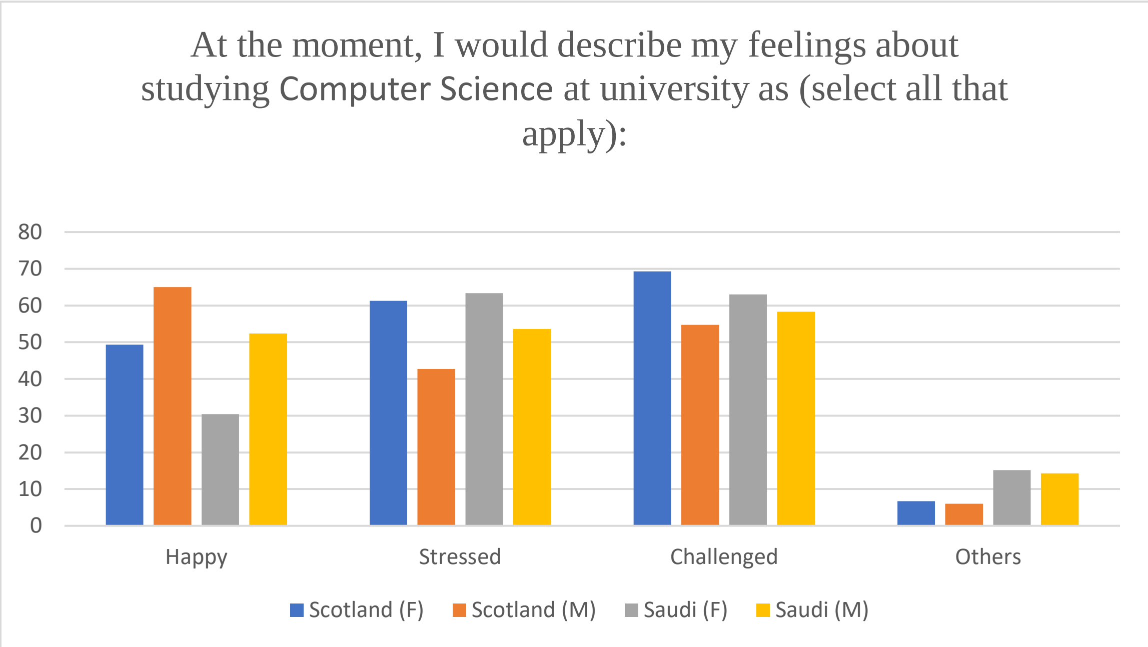

Figure 5-31 Feeling about studying Computer Science at university

Figure 31 shows the respondents' views on their feelings while studying Computer Science. Most of the respondents in both contexts, in Scotland (69.3% females, 54.7% males) and in Saudi Arabia (63% females, 58.3% males), were feeling challenged; similarly, for feeling stressed: in Scotland 61.3% females and in Saudi Arabia 63.4% females and 53.6% males gave this answer, as did 42.7% of male respondents in Scotland. As for feeling happy, most of the male respondents in Scotland (65%) and in Saudi Arabia (52.4%) felt happy about studying Computer Science at the university; in addition, some of the females in Scotland (49.3%) and in Saudi Arabia (30.4%) felt happy. A few respondents identified other feelings, which included "satisfied", "regret", and "worried but determined".

In summary, most of the male respondents in Scotland felt happy, while females in both contexts felt slightly more challenged and stressed.

According to the Kruskal-Wallis test:

- there was no significant difference between males and females in Scotland, while there was a significant difference ($p < .05$) between males and females in Saudi Arabia for Happy.
- there was a significant difference ($p < .05$) between males and females in Scotland, while in Saudi Arabia, there was no significant difference between males and females for Stressed.
- there was no significant difference between males and females in either context for Challenged

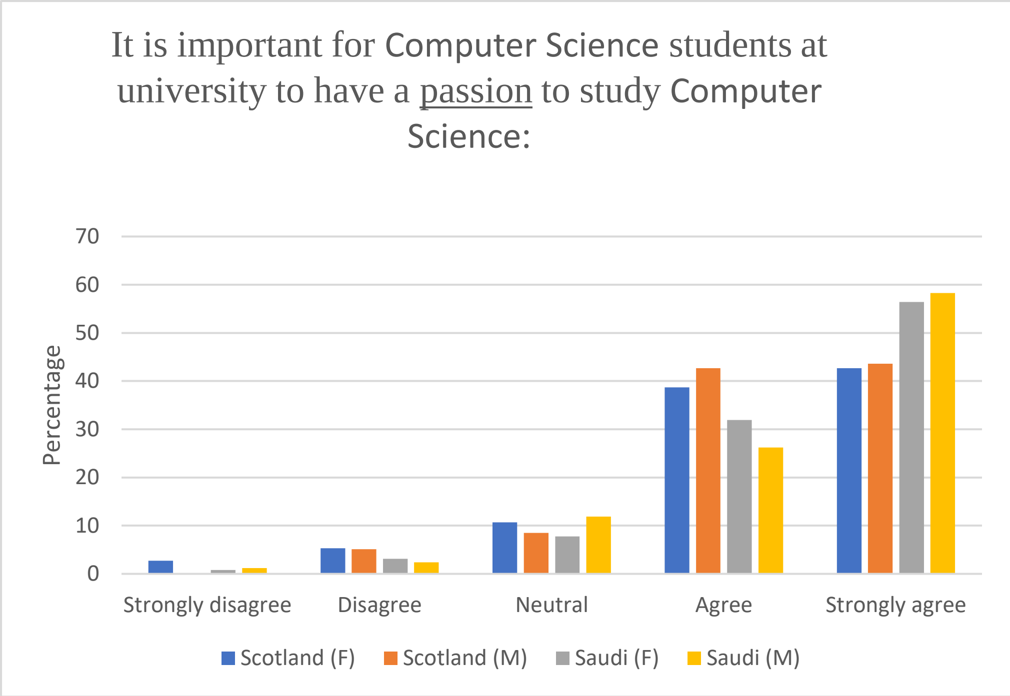

Figure 5-32 Passion for studying Computer Science

Figure 32 shows the importance for Computer Science students at university of having a passion to study Computer Science. Most of the respondents in both contexts, in Scotland (81.4% females, 86.3% males) and in Saudi Arabia (88.3% females, 84.5% males), agreed or strongly agreed that Computer Science students should have a passion to study Computer Science at the university, while a few of the respondents in Scotland (10.7% females, 8.5% males) and in Saudi Arabia (7.8% females, 11.9% males) neither agreed nor disagreed. A few of the respondents in Scotland (8% females, 5.1% males) and in Saudi Arabia (3.9% females, 3.6% males) disagreed or strongly disagreed.

In summary, it is suggested that, for respondents in both contexts, having a passion for Computer Science was an important factor. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

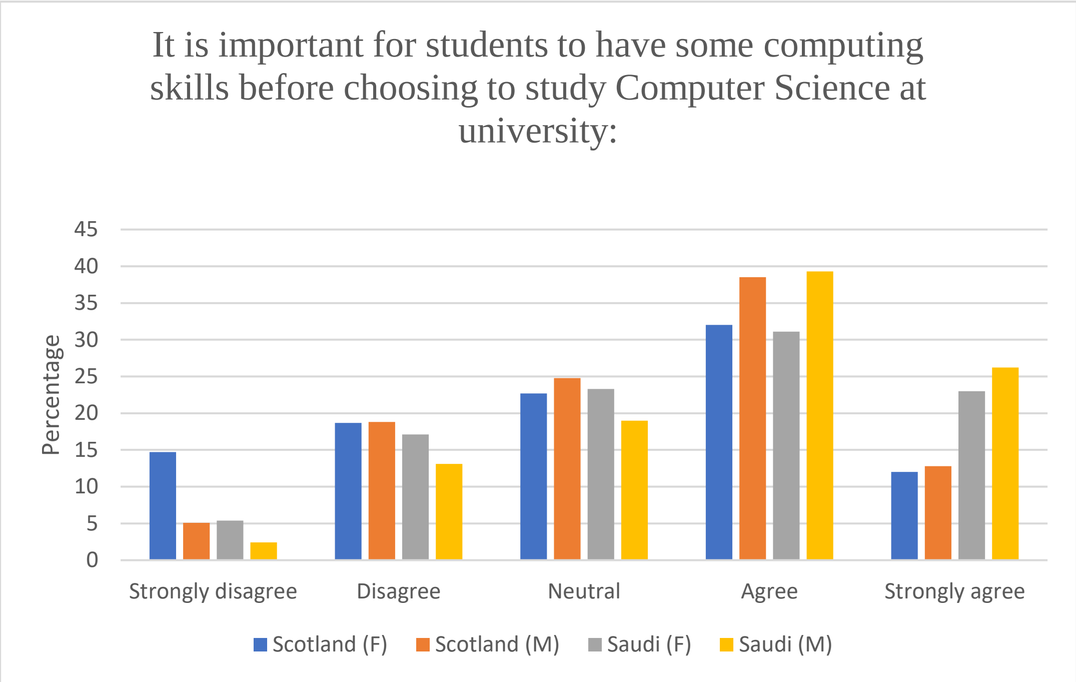

Figure 5-33 It is important to have some computing skills before choosing to study Computer Science at university

Figure 33 shows the respondents' view of the importance of having some Computing skills before choosing to study Computer Science at university. Number of the respondents in both contexts, in Scotland (44% females, 51.3% males) and in Saudi Arabia (54.1% females, 65.5% males), agreed or strongly agreed that Computer Science students should have Some computing skills before studying Computer Science at university, but some of the respondents in Scotland (22.7% females, 24.8% males) and in Saudi Arabia (23.3% females, 19% males) neither agreed nor disagreed. Moreover, some of the respondents in Scotland (33.4% females, 23.9% males) and in Saudi Arabia (22.5% females, 15.5% males) disagreed or strongly disagreed.

Respondents in both contexts said that it was important for students to have some Computing skills before choosing to study Computer Science at university. The

Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

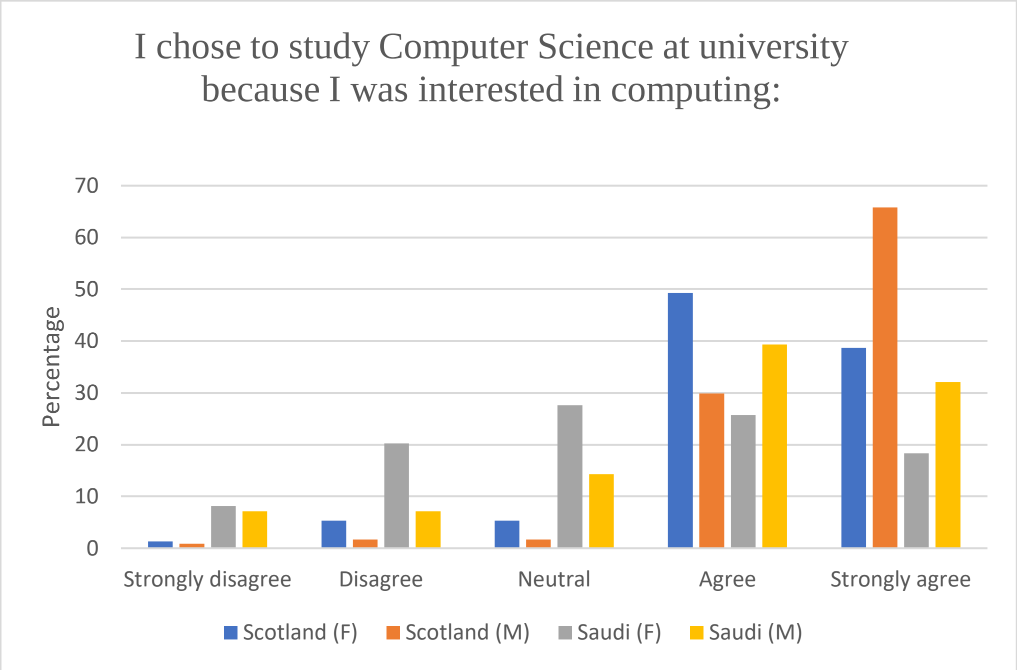

Figure 5-34 Chose to study Computer Science because interested in computing

Figure 34 shows that most of the respondents in both contexts, in Scotland (88% females, 95.7% males) and in Saudi Arabia (44% females, 71.4% males), agreed or strongly agreed that they chose to study Computer Science at university because they were interested in Computing, while a few of the respondents in Scotland (5.3% females, 1.7% males) and some of them in Saudi Arabia (27.6% females, 14.3% males) neither agreed nor disagreed. Also, a few of the respondents in Scotland (6.6% females, 2.6% males) and some of them in Saudi Arabia (28.4% females, 14.2% males) disagreed or strongly disagreed. It seems that interest in Computing was an influential factor for most of the respondents in both contexts. The Kruskal-Wallis test indicated that there was a significant difference ($p < .05$) between males and females in both contexts.

5.7 Outcome expectations

Outcome expectations are the outcomes that are expected from pursuing a Computer Science major at university.

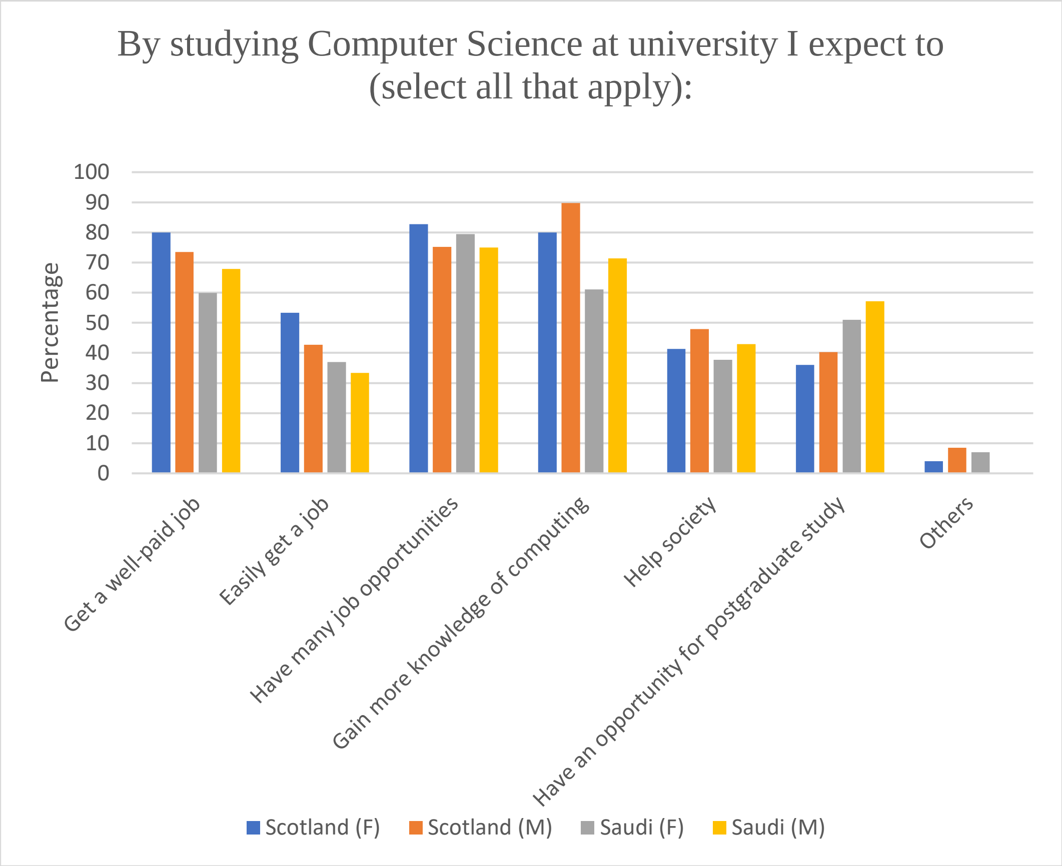

Figure 5-35 Expectations from studying Computer Science at university

The outcome expectations from studying Computer Science at university were classified into four main categories: job prospects, gaining knowledge in the field, helping society, and the opportunity for postgraduate study. These were the main outcomes identified in the qualitative study. Most of the respondents in both contexts, in Scotland (82.7% females, 75.2% males) and in Saudi Arabia (79.4% females, 75% males), expected to gain many job opportunities by studying Computer Science.

Similarly, most of the respondents in Scotland (80% females, 73.5% males) and in Saudi Arabia (59.9% females, 67.9% males) expected to get a well-paid job, whereas number of the respondents in both contexts, in Scotland (53.3% females, 42.7% males) and in Saudi Arabia (37% females, 33.3% males), expected to easily get a job. Gaining more knowledge in Computer Science fields was expected by most of the respondents in both contexts: in Scotland (80% females, 89.7% males) and in Saudi Arabia (61.1% females, 71.4% males), while number of the respondents in Scotland (36% females, 40.2% males) and in Saudi Arabia (51% females, 57.1% males) expected to have the opportunity for postgraduate study.

The expectations from studying Computer Science at university were varied: job opportunities, well-paid jobs, and gaining more knowledge in Computer Science fields are reported by over 50% of respondents in both contexts. In the Kruskal-Wallis test there was a significant difference ($p < .05$) between males and females in Scotland for get a well-paid job, while in Saudi Arabia, there was no significant difference between males and females. For all other expectations there was no significant difference between males and females in either context.

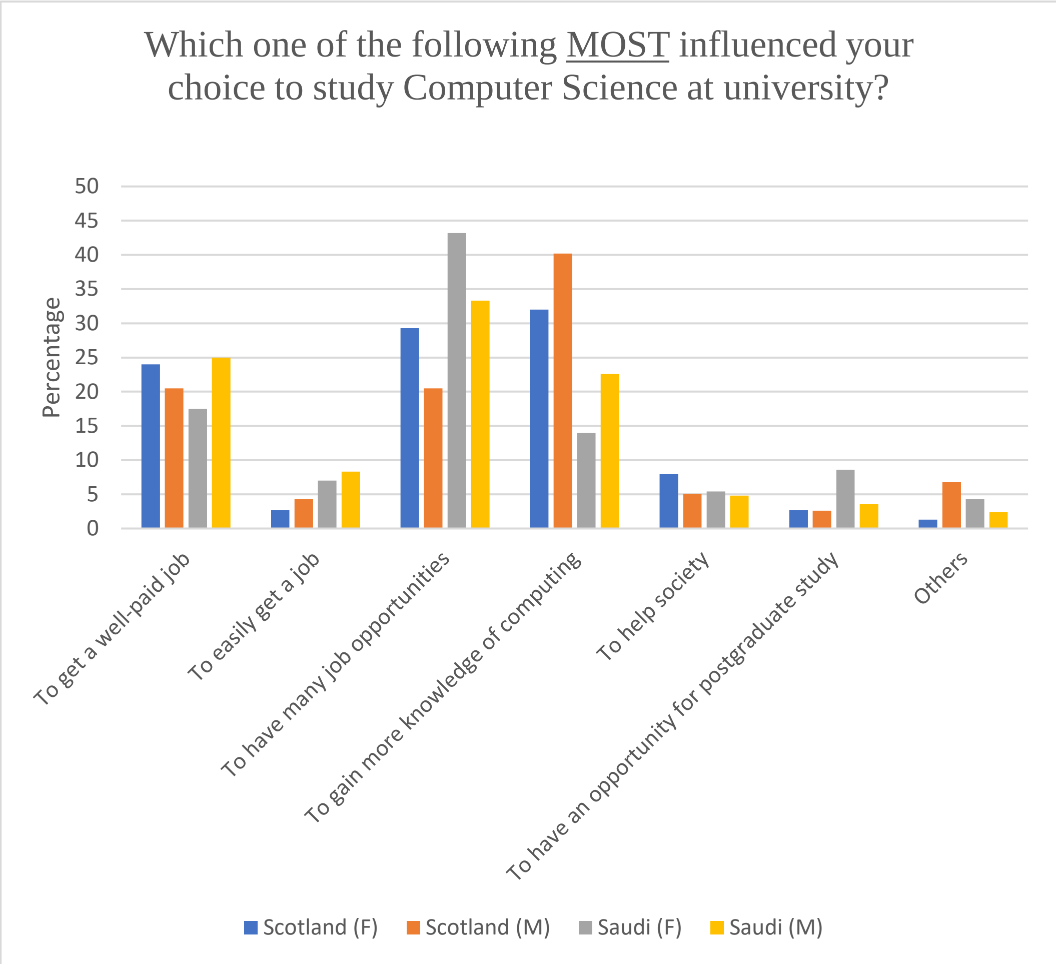

Figure 5-36 Factors which most influenced choice to study Computer Science

Figure 36 shows the factors which most influenced the respondents' choice to study Computer Science. Some of the respondents in both contexts, in Scotland (29.3% females, 20.5% males) and in Saudi Arabia (43.2% females, 33.3% males), were influenced by the prospect of having many job opportunities by studying Computer Science at university, whereas a few of the respondents in Scotland (2.7% females, 4.3% males) and in Saudi Arabia (7% females, 8.3% males) were influenced by the expectation of easily getting a job. Moreover, some of the respondents in Scotland (24% females, 20.5% males) and in Saudi Arabia (17.5% females, 25% males) were influenced by the prospect of getting a well-paid job. Gaining more knowledge in the computing field was an expectation of some of the respondents in both contexts, in Scotland (32% females, 40.2% males) and in Saudi Arabia (14% females, 22.6% males). Only a few of the respondents in both contexts, in Scotland (8% females, 5.1% males) and in Saudi Arabia (5.4% females, 4.8% males), were influenced by the prospect of helping society, while a few respondents in Scotland (2.7% females, 2.6% males) and in Saudi Arabia (8.6% females, 3.6% males) were influenced by the expectation of opportunities for postgraduate study.

The most influential expectation in both contexts was that of job opportunities, as well as getting a well-paid job and gaining more knowledge of Computer Science field. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

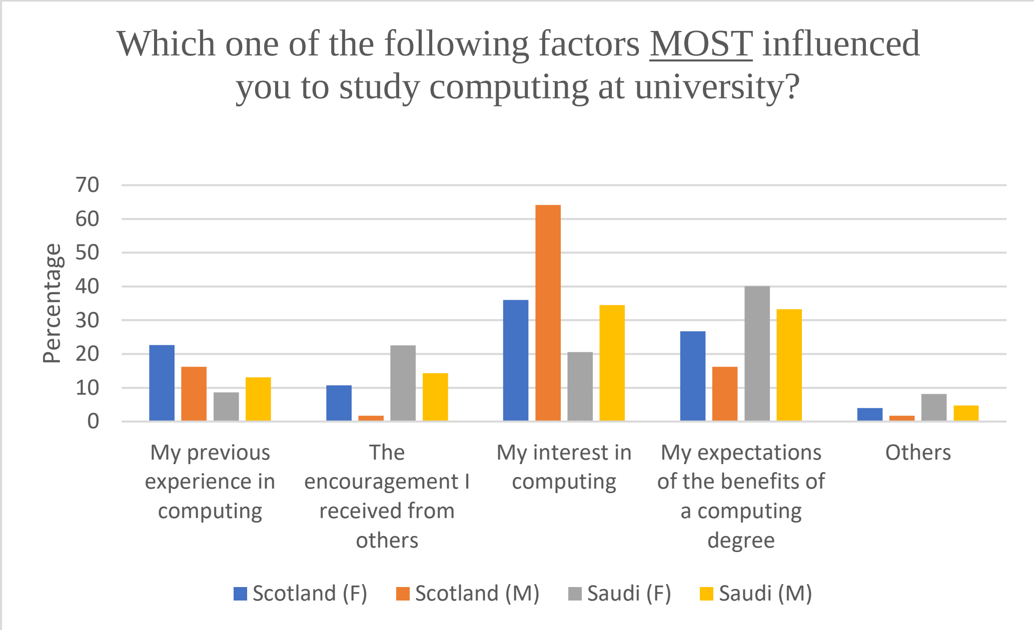

Figure 5-37 Most influential factors in the decision to study Computer Science at university

Figure 37 show the factors that most influenced the respondents to study Computer Science at university. Number of the respondents in Scotland (22.7% females, 16.2% males) and in Saudi Arabia (8.6% females, 13.1% males) were influenced by their previous experience in Computing. Only a few of the respondents in Scotland (10.7% females, 1.7% males) and some in Saudi Arabia, especially females (22.6%), and (14.3%) males, were influenced by encouragement from others. Most of the respondents, especially males in Scotland (64.1%), were influenced by their interest in computing, but this was true also for some of the female respondents in Scotland (36%) and in Saudi Arabia (20.6% females, 34.5% males). Some of the respondents in both contexts, in Scotland (26.7% females, 16.2% males) and in Saudi Arabia (40.1% females, 33.3% males), were most influenced by their expectations of the benefits of a Computer Science degree. A few of the respondents in both contexts, in Scotland (4% females, 1.7% males) and in Saudi Arabia (8.2% females, 4.8% males), were most influenced by other factors such as opportunities to travel abroad, and GPA at high school.

This highlights that interest in Computing was the most influential factor for both genders in Scotland and for Saudi males, while expectations of the benefits of a Computer Science degree constituted the most influential factor for females in Saudi Arabia. However, previous experience in computing and encouragement from others did not seem to be the most influential factors for many of the respondents. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

5.8 Perceptions

The topic of perceptions, which was created from the qualitative analysis, concerns the potential influence of society's view of Computer Science students.

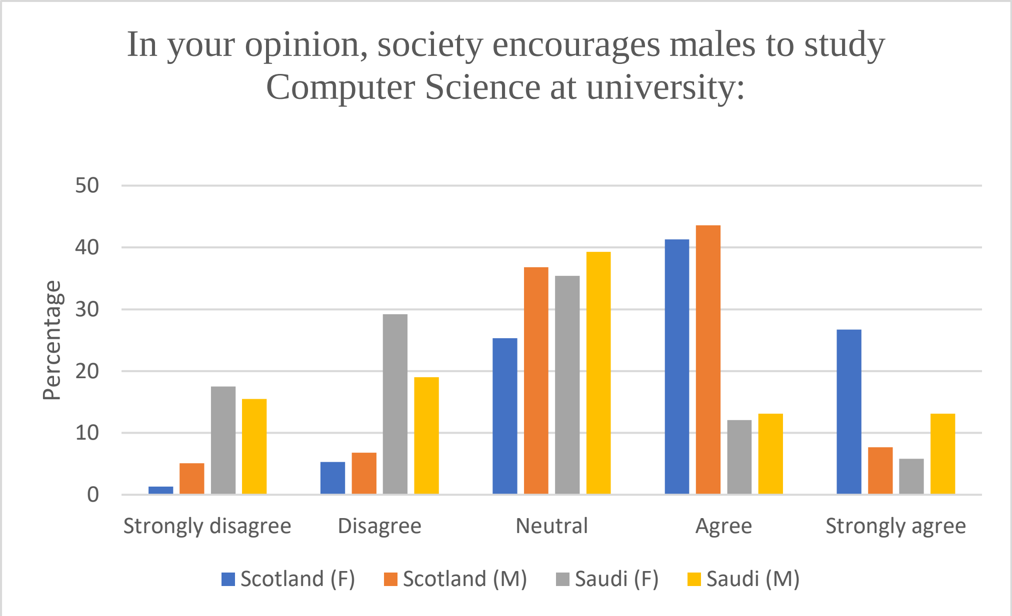

Figure 5-38 Society encourages males to study Computer Science at university

Figure 38 shows the respondents' opinions as to whether society encourages males to study Computer Science at university. Most of the respondents in Scotland (68% females, 51.3% males) agreed or strongly agreed that society encourages males to study Computer Science at university, and some of the respondents in Saudi Arabia (17.9% females, 26.2% males) also agreed or strongly agreed. Number of the respondents in Scotland (25.3% females, 36.8% males) and in Saudi Arabia (35.4% females, 39.3% males) neither agreed nor disagreed. A few of the respondents in Scotland (6.6% females, 11.9% males), while some of the respondents in Saudi Arabia (46.7% females, 34.5% males) disagreed or strongly disagreed.

This suggests that there is a difference between the respondents' opinions in the two contexts with regard to society encouraging males to study Computer Science at university. In Scotland, the view of many was that society encourages males to study Computer Science at university, whereas in Saudi Arabia there was much less support for this view. The Kruskal-Wallis test indicated that there was a significant difference ($p < .05$) between males and females in both contexts.

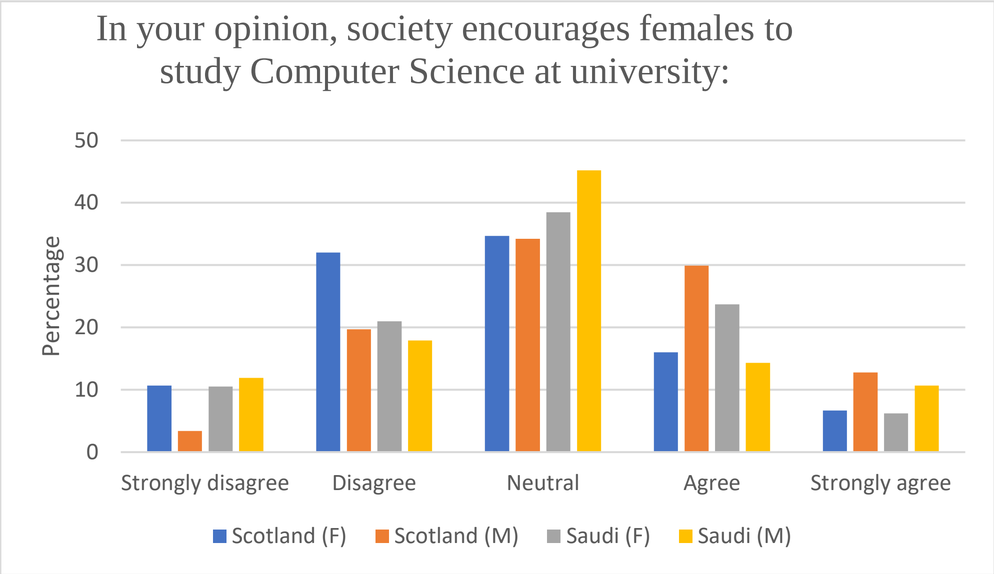

Figure 5-39 Society encourages females to study Computer Science at university

Figure 39 shows the respondents' opinions on whether society encourages females to study Computer Science at university. Some of the respondents in both contexts, in Scotland (22.7% females, 42.7% males) and in Saudi Arabia (29.9% females, 25% males), agreed or strongly agreed that society encourages females to study computing at university, while some of the respondents in Scotland (34.7% females, 34.2% males) and in Saudi Arabia (38.5% females, 45.2% males) neither agreed nor disagreed. Some respondents in Scotland (42.7% females, 23.1% males) and in Saudi Arabia (31.5% females, 29.8% males) disagreed or strongly disagreed.

This suggests that there is a difference between the respondents' opinions, particularly in Scotland, regarding society's encouragement of females to study Computer Science at university. The view of many females in Scotland was that society does not encourage females to do so. The Kruskal-Wallis test indicated that there was a significant difference ($p < .05$) between males and females in Scotland, while in Saudi Arabia, there was no significant difference between males and females.

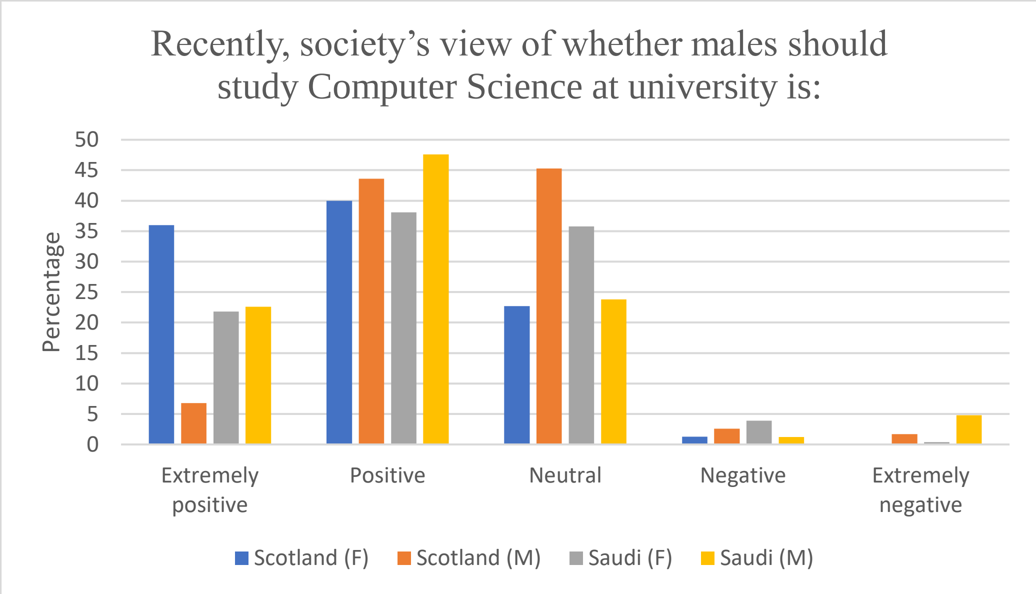

Figure 5-40 Society's recent views on males' study of Computer Science at university

According to the respondents' opinions of society's view, Figure 40 shows the view that males should study Computer Science at university. Most of the respondents in both contexts, in Scotland (76% females, 50.4% males) and in Saudi Arabia (59.9% females, 70.2% males), thought the view was positive or extremely positive, while some of the respondents in Scotland (22.7% females, 45.3% males) and in Saudi Arabia (35.8% females, 23.8% males) regarded it as neither positive nor negative. Only a few of the respondents in both contexts, in Scotland (1.3% females, 4.3% males) and in Saudi Arabia (4.3% females, 6% males), thought that society's view was negative or extremely negative.

This suggests that respondents in both contexts generally thought that society's recent view of whether males should study Computer Science at university was positive.

In the Kruskal-Wallis test, there was a significant difference ($p < .05$) between males and females in Scotland, while in Saudi Arabia, there was no significant difference between males and females.

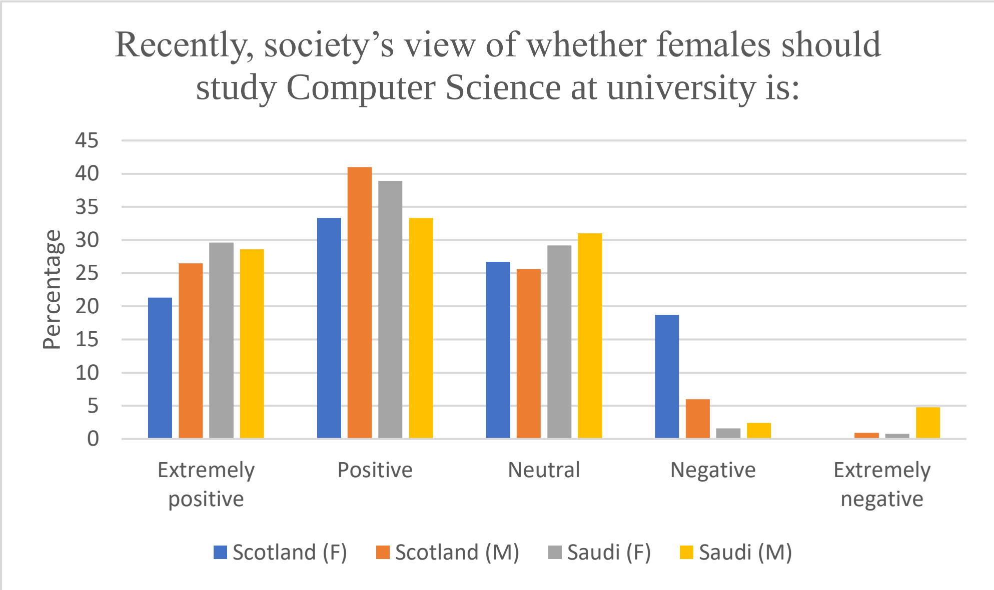

Figure 5-41 Society recent views on females' study of Computer Science at university

According to the respondents' opinions on society's view, Figure 41 shows the view that females should study Computer Science at university. Most of the respondents in both contexts, in Scotland (54.6% females, 67.5% males) and in Saudi Arabia (68.5% females, 61.9% males), thought that society's view was positive or extremely positive, while some respondents in Scotland (26.7% females, 25.6% males) and in Saudi Arabia (29.2% females, 31% males) thought it was neither positive nor negative. A few of the respondents in both contexts, in Scotland (18.7% females, 6.9% males) and in Saudi Arabia (2.4% females, 7.2% males), thought that society's view was negative or extremely negative.

This suggests that respondents in both contexts generally thought that society's view of whether females should study Computer Science at university was positive. However, compared to the previous Figure 40, indicating beliefs on society's view as to whether males should study Computer Science at university, there was a more negative perspective from females in Scotland. The Kruskal-Wallis test indicated that there was no significant difference between males and females in either context.

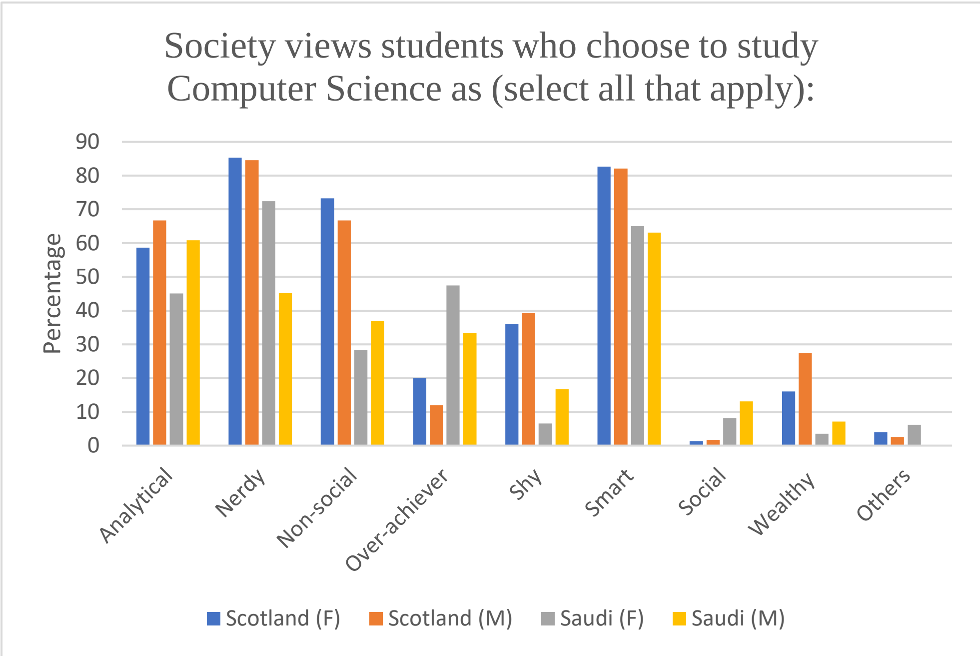

Figure 5-42 Characteristic of Computer Science students by society

According to the results shown in Figure 42, the respondents thought that the most common characteristic of Computer Science students as viewed by society in both contexts, in Scotland (82.7% females, 82.1% males) and in Saudi Arabia (65% females, 63.1% males), was smart, followed by nerdy in Scotland (85.3% females, 84.6% males) and in Saudi Arabia (72.4% females, 45.2% males). The other characteristics of Computer Science students are presented below for both contexts:

Analytical: in Scotland by 58.7% females, 66.7% males and in Saudi Arabia by 45.1% females, 60.8% males.

Non-social: in Scotland by 73.3% females, 66.7% males and in Saudi Arabia by 28.4% females, 36.9% males.

Social: in Scotland by 1.3% females, 1.7% males and in Saudi Arabia by 8.2% females, 13.1% males.

Over-achiever: in Scotland by 20% females, 12% males and in Saudi Arabia by 47.5% females, 33.3% males.

Shy: in Scotland by 36% females, 39.3% males and in Saudi Arabia by 6.6% females, 16.7% males

Wealthy: in Scotland by 16% females, 27.4% males and in Saudi Arabia by 3.5% females, 7.1% males.

The respondents were given the option of adding any other characteristics, and a few of the respondents in both contexts, in Scotland (4% females, 2.6% males) and in Saudi Arabia only (6.2% females), added other characteristics, such as: elegant, patient and more casual.

The characteristic of Computer Science students which was chosen by most of the respondents in both contexts was smart. Nerdy was selected by most of the respondents in Scotland and of the females in Saudi Arabia. Moreover, non-social was chosen by most of the respondents in Scotland. Over 50% of those who responded in Scotland, and of males in Saudi Arabia, selected analytical. It is noticeable that many more in Scotland highlighted shy compared to Saudi, whereas many more in Saudi highlighted over-achiever. In the Kruskal-Wallis test there was no significant difference between males and females in either context for Analytical, non-Social, Smart, Social and Wealthy. While, for Nerdy, Shy and Over-achiever the Kruskal-Wallis test indicated that there was no significant difference between males and females in Scotland, while there was a significant difference ($p < .05$) between males and females in Saudi Arabia.

Summary of the Kruskal-Wallis test results:

There were four categories of results using the Kruskal-Wallis test for statistically significant differences between male and female responses. The first category is where there was no significant difference according to the tests. Many of the responses fall into this category.

The second category is where there was a statistically significant difference between males and females in both contexts. All responses were higher for males than females. Responses in this category included: the influence of playing video games on the choice to study Computer Science, confidence in ability to study Computer Science at university, chose to study Computer Science because of interest in computing, society's encouragement of males to study Computer Science at university.

The third category is where there was a significant difference between males and females in Scotland but not in Saudi Arabia. Responses in this category included: learning to use applications such as word processors at school (males higher), self-taught study outside of school (males higher), no study of computing outside of school (females higher), skills in computing before studying at university (males higher), regard for their ability to study Computer Science at university (males higher), currently stressed studying Computer Science at university (females higher), expectations of a well-paid job (females higher), society's encouragement for females to study Computer Science at university (males agree more), recent view in society of whether males should study computing (females more positive).

The fourth category is where there was a significant difference between males and females in Saudi Arabia but not in Scotland. Responses in this category included: the quality of the computing experience at school (females higher), school computing helped prepare for University computing (females higher), had an internship or worked in computing prior to university (males higher), influence of prior experience (males higher), receiving encouragement from a parent (females higher), currently happy studying Computer Science at university (males higher), society's view of students who study Computer Science as nerdy (female higher), shy (male higher) and over-achiever (female higher).

5.9 Open-Ended Questions

There were also optional open-ended questions in the questionnaire to give the participants space, in case they should want to add any other factors that could encourage or discourage students, whether male or female, to study Computer Science at university. These questions were analysed by means of content analysis, as discussed in the Methodology chapter in relation to analysing the qualitative phase. In the following sections, the results will be presented.

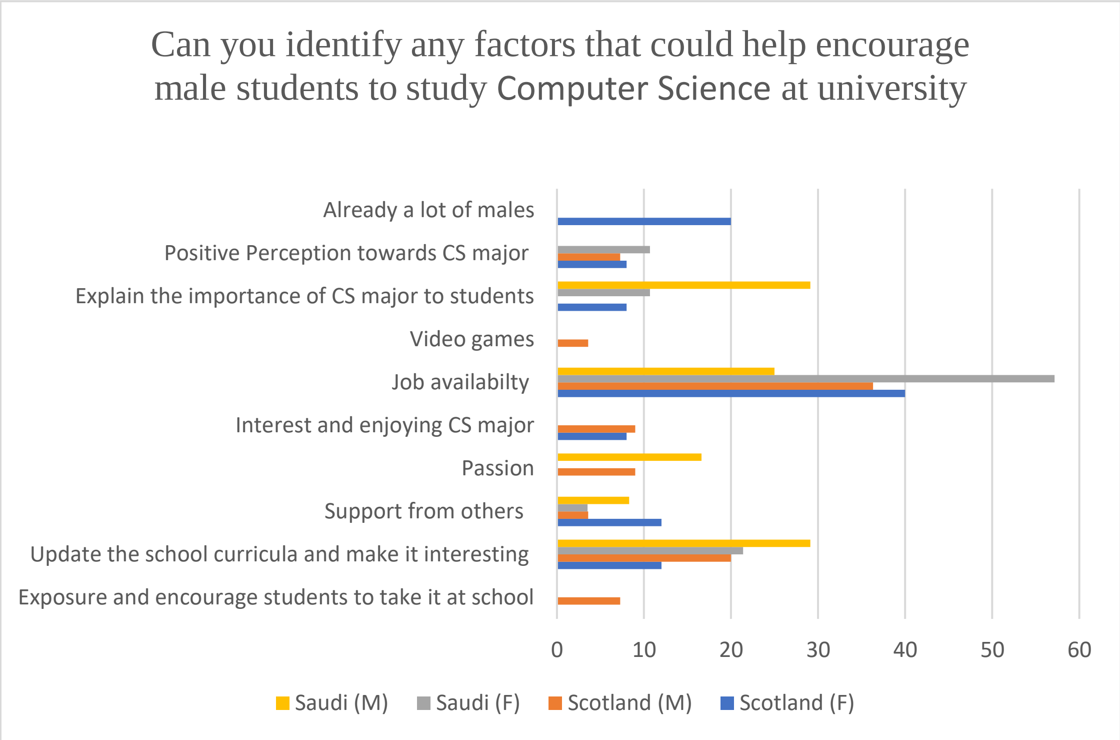

Figure 5-43 Factors that could encourage males to study a Computer Science major

There were a number of respondents who answered the question about factors that could encourage males to study a Computer Science major. In Scotland, there were 25 females and 55 males who responded, while in Saudi Arabia, there were 28 females and 24 males who did so. Figure 43 illustrates the percentage of these respondents. Thus, number of the respondents in Scotland (40% females, 36.3% males) and in Saudi Arabia (57.14% females, 25% males) mentioned job availability as a motive for seeking a Computer Science degree. The other two factors mentioned by both genders in both contexts were: Update the Computing curricula at school and make it interesting, referred to in Scotland by 12% females, 20% males and in Saudi Arabia by 21.4% females, 29.1% males; and Support from others, mentioned in Scotland by 12% females, 3.6% males and in Saudi Arabia by 3.5% females, 8.3% males. The following factors were not reported by both genders or in both contexts: Explain the importance of the Computer Science major to students, mentioned in Scotland by 8% females and in Saudi Arabia by 10% females, 29.1% males.

Positive perception of Computer Science students and the Computer Science major: named in Scotland by 8% females, 7.27% males and in Saudi Arabia by 10.7% females.

Interest in and enjoying Computer Science major: in Scotland only by 8% females, 9% males.

Have a passion for Computer Science: 9% males in Scotland and 16.5% males in Saudi Arabia.

Expose the students to Computing and encourage them to take it at school: mentioned in Scotland by 7.27% males, and video games by 3.6% males.

However, some of the female respondents in Scotland (20%) stated that the Computer Science major already contained a lot of males, so they did not need encouragement.

The following quotations present some of these factors:

"*Interesting coursework in school and tasks that have a product that the students will care about. Current tasks are basic and irrelevant to high school students.*"

"Encouraging more schools to teach relevant skills and programming languages (i.e. Java or Python as opposed to Visual Basic)."

"Wide variety of jobs available."

"Show them the variety of different jobs / sectors they could pursue."

"Personally, I believe that the only way people can be encouraged to study something at university is when they already have a passion for the degree."

"If you really like computing and want to do more of it, take it at uni. And I would say that to any gender."

"Relevance to video games", "Family", "good teacher."

"*Do we really need encouragement? It already is mostly all males*."

To conclude, a variety of factors were suggested that could help to encourage males to study a Computer Science major at university. A number of students in both contexts indicated job availability with a Computer Science degree and updating the Computing curriculum at school to make it more enjoyable. However, some of the females in Scotland said that Computer Science fields already contain a lot of males.

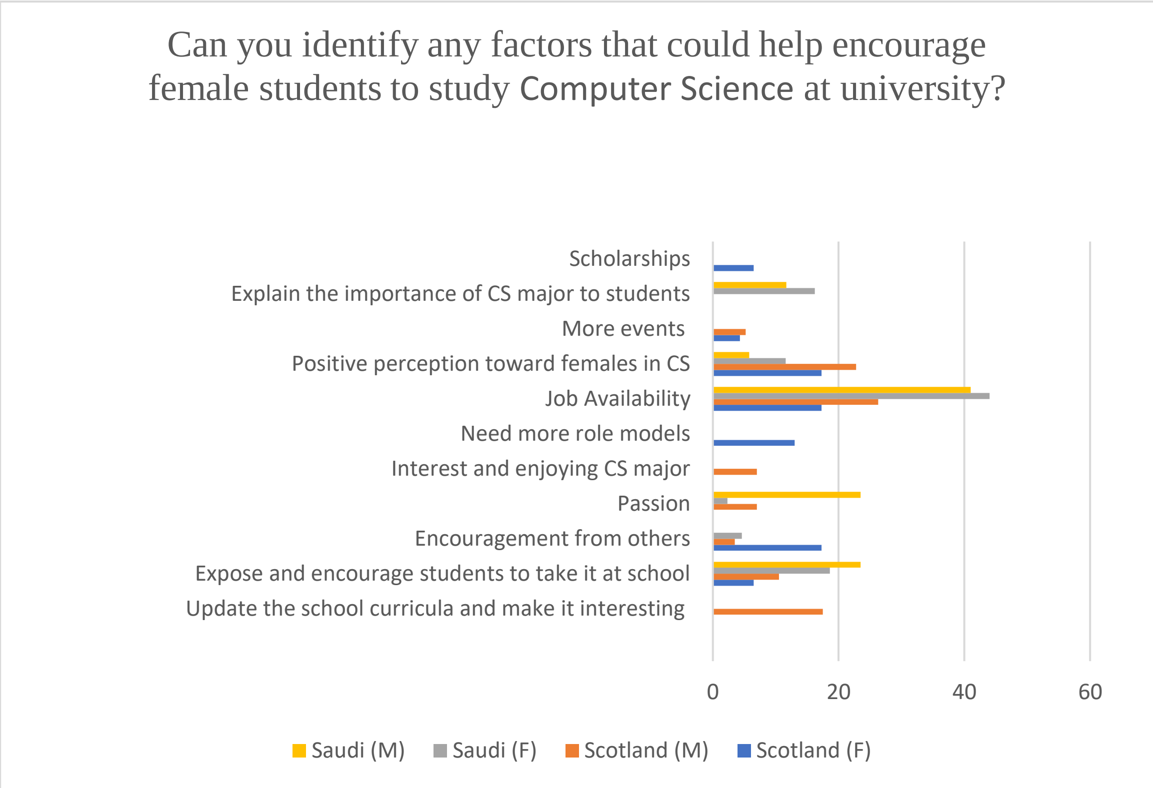

Figure 5-44 Factors that could encourage females to study Computer Science major

There were a number of participants who responded to the question about factors that could encourage females to study the Computer Science major. The numbers of responses are as follows. In Scotland there were 46 from females and 57 from males, in Saudi Arabia 43 from females and 17 from males. Figure 44 shows the percentages of these respondents (in Scotland, 17.3% females and 26.3% males, and in Saudi Arabia, 44% females and 41% males) who stated that job availability with a Computer Science degree was a factor. The other two factors mentioned by both genders in both contexts were: Expose the students to Computing and encourage them to take it at school, mentioned in Scotland by 6.5% females and 10.5% males and in Saudi Arabia by 18.6% females and 23.5% males; and positive perception of females in a Computer Science major, mentioned in Scotland by 17.3% females and 22.8% males and in

Saudi Arabia by 11.6% females and 5.8% males. The following factors were not reported by all genders:

Encouragement from others: in Scotland by 17.3% females, 3.5% males and in Saudi Arabia by 4.6% females. Have a passion for the Computer Science major: in Scotland by 7% males and in Saudi Arabia by 2.3% females, 23.5% males. Explain the importance of the Computer Science field to students: in Saudi Arabia by 16.2% females, 11.7% males. More events for females in Scotland: only by 4.3% females, 5.2% males.

There were some factors that were identified by males only in Scotland. For example, update the Computing curriculum at school and make it interesting: by 18%. Out of the 57 respondents, 7% mentioned interest in and liking the Computer Science major as a factor that could encourage females to study Computer Science, while other factors were indicated by females only in Scotland, such as the need for more role models, mentioned by 13%, and scholarships, mentioned by 6.5%.

The following quotations demonstrate some of these factors:

"Encourage uptake in computing more at high school."

"Opportunities outside of school such as hackathons for teens during the summer are the best way to encourage people who may be interested in Computing."

"More female teaching staff."

"I would say it needs to come from teachers and family during secondary school. A lot of friends said they did not believe they could do it. So, I think belief and faith in them as a factor."

"Encouraging female students to understand that studying computing isn't just for 'nerdy' boys. You can excel on this course without being interested in games or geeky things. In fact, it's a great degree to get if you're an outgoing social person, as most jobs in this field encourage group work and so having social skills is a real asset."

"More female faculty members! I didn't have a single female lecturer for my first two years of undergrad."

"Promoting more women in the computing industry and sharing success stories of how women were able to succeed in a male dominated industry."

"Explaining what topics can be learned in Computer Science."

"Presentations in schools, practical demonstrations by current uni. Students."

"As a female, I would say that what puts off girls from computer science is the stereotype on one hand and the fact that the big majority of students are male. I think that all the campaigns led to encourage female students to apply are good and going in the right direction, but I do not know if they really affect the stigma of computer science. It might take time and pushing these sorts of campaigns, making society aware of a change."

"The main reason I think that not many female students decide to study computing as a degree is that they feel they are going to be judged and not treated equally in their future jobs, which is true. Therefore, I would make teachers at high school encourage more female students to take this degree and show them the power of computing and how interesting it can be."

"It comes down to the schools and in schools making sure all pupils with an interest in any form of digital technology get to learn computing; currently this is not the case. Especially for females who really need to be told that the industry wants them. Society just doesn't speak for what females can ultimately do, which is whatever they aspire to be."

To sum up, a variety of factors were identified to help encourage females to study a Computer Science major at university. Some of the students in both contexts referred to the job availability with a Computer Science degree, exposing the students to computing and encouraging them to take it at school, and emphasizing the positive perception of females in a Computer Science major.

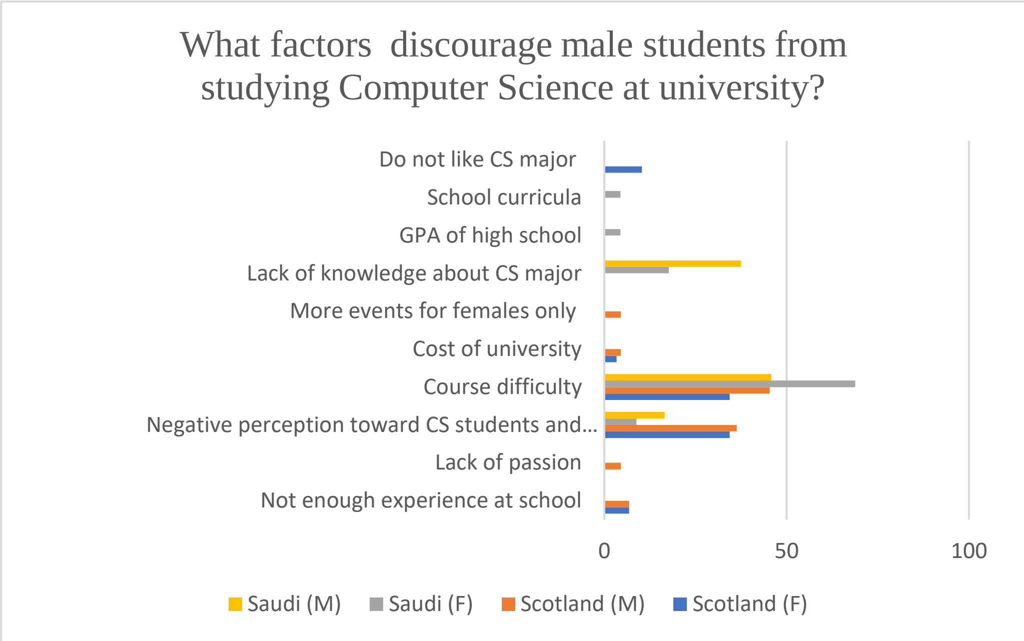

Figure 5-45 Factors that could discourage males from studying a Computer Science major at university

There were a number of participants who responded to the question about factors that could discourage males from studying a Computer Science major. The responses were as follows. In Scotland there were 29 responses from females and 44 from males; in Saudi Arabia 45 from females and 24 from males. Figure 45 shows that some of the respondents in Scotland (45% females, 45.4% males) and in Saudi Arabia (68.8% females, 45.8% males) stated that course difficulty seemed to be discouraging students from choosing to study a CS major. Another factor mentioned by both genders in both contexts is the negative perception of CS students and the major: reported in Scotland by 34.4% females, 36.3% males and in Saudi Arabia by 8.8% females, 16.6% males. The following factors were not reported by both genders or in both contexts:

Lack of knowledge about Computer Science major: 17.7% females and 37.5% males in Saudi Arabia.

Not enough experience at school: mentioned by 6.8% females and 6.8% males in Scotland; and Cost of university: mentioned by 3.4% females and 4.5% males in Scotland.

Some factors were cited by the male respondents in Scotland only, such as lack of passion for the Computer Science field: mentioned by 4.5%, and more events for females only: by 4.5%. Another factor stated by female respondents in Scotland only, by 10.3%, was that students do not like the Computer Science major.

Other factors were mentioned by the female respondents in Saudi Arabia only, such as the school curricula by 4.4%, and 4.4% low GPA (Grade Point Average) at high school.

The following excerpts present some examples of these factors:

"*It is really hard", "Not as easy as many people think going in."*

"They have no interest in computing."

"Not really understanding what it involves."

"They don't know about the major and what is covered."

"Thinking that you need to know a bunch about Computer Science before starting."

"Not being able to fit in with the nerdy social view and not being smart enough and being a total geek about computers."

"High requirements such as GPA marks."

"Stigma against it, perception it's boring, people overestimating how complicated programming is."

"Computer scientists are often seen as nerds and anti-socials, which might put off a lot of male students from studying it, especially the 'cool' male students who want to maintain their good reputation and popularity."

"Females receive priority and gender-specific bursaries/awards."

"The same as the female ones. Everyone should follow his/her passion."

To sum up, several factors were reported that could discourage male students from choosing to study a Computer Science major at university. Most of the students in both contexts mentioned the difficulty of the course and the negative perception of Computer Science students and the major. However, some of the students in Saudi Arabia only mentioned a lack of knowledge about the Computer Science major.

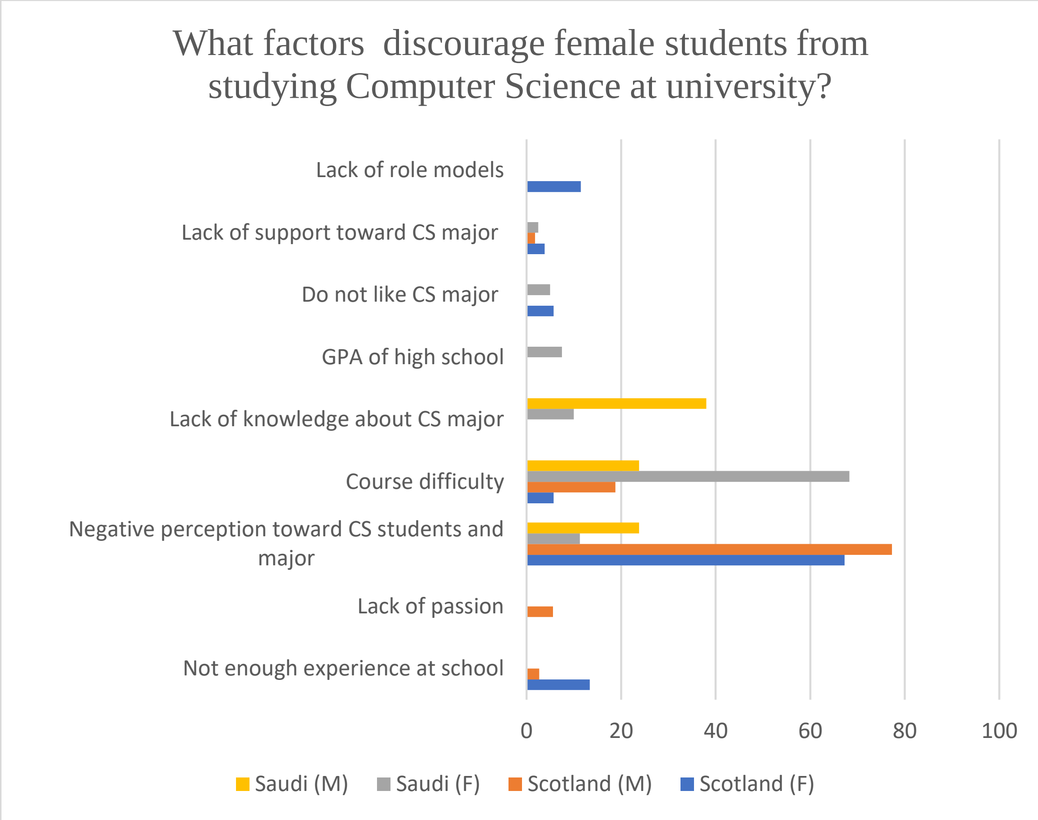

Figure 5-46 Factors that could discourage females from studying a Computer Science major at university

There were a number of respondents who answered the question about factors that could discourage females from studying a Computer Science major at university. The numbers of responses are as follows. In Scotland there were 52 responses from females and 53 from males, whereas in Saudi Arabia there were 79 from females and 21 from males. Figure 46 shows that most of the respondents in Scotland (67.3% females, 77.3% males), but only some of them in Saudi Arabia (11.3% females, 23.8% males), noted the negative perception of Computer Science students and the major as the main factor that could discourage females from studying a Computer Science major. Other factors mentioned by both genders in both contexts is the course difficulties, cited in Scotland by 5.7% females, 18.8% males and in Saudi Arabia by 68.3% females, 23.8% males. A few of the respondents in Scotland (3.8% females, 1.8% males) and in Saudi

Arabia (2.5% females) stated that there was a lack of support for the Computer Science major. The following factors were reported by only some respondents:

Lack of knowledge about the Computer Science major in Saudi Arabia: reported by 10% females, 38% males.

Not enough experience at school: mentioned in Scotland by 13.4% females, 2.7% males.

Female respondents in Scotland (5.7%) and in Saudi Arabia (5%) stated that the students do not like Computer Science majors.

Other factors were mentioned by only one gender, such as, lack of passion for Computer Science major: mentioned in Scotland by 5.6% males; lack of role models in Computer Science field: in Scotland by 11.5% females; and low high school GPA: in Saudi Arabia by 7.5% females.

The following excerpts give some examples of these factors:

"Social inequality is a big factor that discourages female students from studying computing. Also, it is a well-known fact that companies tend to hire male computer scientists and females are less likely to become managers in this area."

"Being female and western society having weird stereotypes around that."

"Cyclical, but the gender imbalance itself – I remember going to university interviews/open days and being the only female there, which was definitely off-putting."

"Some may think they have to be particularly good at maths to succeed or they need to have prior experience in programming before starting their degree."

"Lack of encouragement from society."

"How the massive a difference in the ratio of males to females in computing is portrayed. My family advised me against studying computing as it is so male dominated that they won't want to hire a woman."

"I think male/female ratio and the sometimes-negative connotations of the subject (e.g. nerdy, etc). Also, a lot of girls in my school saw it as an admin subject and didn't take it because of that."

"Improvements in school computing ensuring that women are not discouraged from taking computing at school."

"They don't like the subject."

"They have no interest in computing."

"Society bias. Computer Science is for guys not for girls, and family pressures, a lot of parents still didn't see how powerful this subject is going to be in the future."

"Not a lot of role models; both over the media and at home."

To sum up, most factors that could discourage female students from choosing to study a Computer Science major at university, as reported by respondents in both contexts, are the course difficulty and the negative perception of Computer Science students and the major, particularly for most of the respondents in Scotland. However, some of the students in Saudi Arabia only reported a lack of knowledge about the Computer Science major.

5.10 Chapter Summary

This chapter has presented the results of the descriptive statistics of the data collected by questionnaire from 192 participants (117 males, 75 females) in Scotland, and 341 participants (84 males, 257 females) in Saudi Arabia.

The main findings in terms of prior experience were that:

- For most in Scotland the overall prior experiences were above average. They were excellent for females in Saudi but below average or poor for males in Saudi.

- The Computing subjects at school helped both genders in Scotland to prepare to study Computer Science at university. In Saudi Arabia, the Computing subjects at school did not help them.

- The level of difficulty of the Computing subject that was studied at school in both contexts ranged between moderate and easy.

- The Computing at school was mostly fun in both contexts.

- Most of the respondents in Saudi Arabia and females in Scotland had not studied Computing outside the school curriculum, while most of the males in Scotland had some self-learning.

- The overall experience of Computing before university in both contexts ranged across average, good, and excellent. There were some respondents in the Saudi context who reported a poor experience.

- Most of those surveyed in Scotland agreed that the experience of Computing before university influenced them to choose to study Computer Science at university, whereas this was not the case in the Saudi context.

The main findings in terms of social support were that:

- Both genders in Scotland received encouragement from a wide range of sources to study Computer Science. In Saudi Arabia some of the students received encouragement from their family, while most of them did not receive any encouragement to study Computer Science at university. In both contexts, the family and the school can play an important role in students' decision to study Computer Science at university.

In terms of self-efficacy, the main findings were that:

- The respondents seemed motivated to study Computer Science at university by having good skills in Computing, Maths and problem-solving, by enjoyment of creating and designing new things, playing video games and using technology in their daily life. However, females in both contexts were not motivated by playing video games.

- Apart from females in Scotland, the respondents in both contexts were mostly confident in their ability to study computing before coming to university. When at university, most felt confident in their ability to study Computer Science at university.

- Most of the males in Scotland felt happy, while females in both contexts felt more challenged and stressed.

- A passion for Computer Science was an important factor. It seems that interest in computing was an influential factor for most of the respondents in both contexts.

- Respondents in both contexts said that it is important for students to have some computing skills before choosing to study Computer Science at university.

The most influential outcome expectation in both contexts appears to have been the many job opportunities, prospects of a well-paid job, and gaining more knowledge of computing.

In Scotland the view of many was that society encourages males to study Computer Science at university, whereas in Saudi Arabia there was much less support for this view. The view of many females in Scotland was that society does not encourage females to study Computer Science at university. Respondents in both contexts generally thought that society’s view as to whether females should study Computer Science at university is positive. However, there was a more negative perspective from females in Scotland.

In terms of the main characteristics of Computer Science students, smart was chosen by most of the students in both contexts. Nerdy was selected by most of the students in Scotland and females in Saudi Arabia. Non-social was chosen by most of the students in Scotland. More than half of those who responded in Scotland, and males in Saudi Arabia, selected analytical.

A number of factors were identified to help encourage males to study a Computer Science major at university, particularly: job availability with a Computer Science degree and updating the computing curriculum at school to make it more enjoyable. Some females in Scotland said that Computer Science fields already have a lot of males.

A number of factors were identified to help encourage females to study a Computer Science major at university: job availability with a Computer Science degree, exposing female students to computing and encouraging them to take it at school, and also emphasizing the positive perception of females in a Computer Science major.

Several factors were identified that could discourage male students from choosing to study a Computer Science major at university: the course difficulty and negative perception towards a Computer Science major. Some in Saudi Arabia also identified a lack of knowledge about the Computer Science major.

Several factors were identified that could discourage female students from choosing to study a Computer Science major at university: the course difficulty and negative perception towards Computer Science major, particularly for most of the respondents in Scotland. Some in Saudi Arabia only reported a lack of knowledge about the Computer Science major.

The following chapter will discuss the results which were presented in this chapter and in the previous chapter.

Chapter 6: Discussion

6.1 Introduction

The findings of this study were presented in Chapter 4 and Chapter 5, respectively. The first phase of this study consisted of the semi-structured interviews (qualitative), and the main findings were presented in Chapter 4. The second phase, which was conducted after the interviews, was the online questionnaire (quantitative), and the main findings were presented in Chapter 5. These two phases were used to address the objective of this study, which was to investigate the factors that influenced the students (males and females) to choose to study a Computer Science major at university in two different contexts, Scotland and Saudi Arabia. To address this objective, this study attempts to answer the following research questions:

RQ1: What is the role of prior experience in computing in influencing students to choose to study a Computer Science major?

RQ2: What is the role of social support in influencing students to choose to study a Computer Science major?

RQ3: What is the role of self-efficacy in influencing students to choose to study a Computer Science major?

RQ4: What is the role of outcome expectations in influencing students to choose to study a Computer Science major?

RQ5: What is the role of perceptions of Computer Science in influencing students to choose to study a Computer Science major?

This chapter presents a discussion of the findings of this study which answered the above questions.

There are numerous factors that could influence students to choose their major at university. This study found number of factors that could influence Computer Science students based on some of the SCCT (Lent et al., 1994) constructs. Moreover, it also found that the perception of students can influence the students' choice to study Computer Science. According to the findings of the interviews and surveys, some of these factors seem to be strong influences, while others did not seem to have a major effect on the students when they chose their Computer Science major. However, the results of this study provide numerous insights into the factors that influenced the Computer Science students (both males and females) to choose to study a Computer Science major at university in two different contexts, Scotland and Saudi Arabia.

The following sections will present the discussion of the results which were presented in Chapter 4 and Chapter 5.

6.2 Discussion

6.2.1 Prior experience

Prior experience refers to any previous experience in computing disciplines that students had before choosing to study a Computer Science major at university. According to the SCCT, prior experiences for students could influence their academic choice. These experiences can be earned from Computing curriculum at schools or external activities, such as online courses. These two ways are discussed in the following points.

- **Formal Learning**

Computing subject at schools can build students' skills related to computer science fields. The findings of this study confirmed that most of the students have studied Computing subjects at schools. Based on the findings of the interviews, there were many quotes from participants which indicated a shared view that what was taught at school was 'basic,' e.g., how to use a computer, applications and the internet, IT, Excel, and limited use of Visual Basic. The results of the survey also confirm this. Thus, some of the Computing subjects at school just focus on using applications or some of the basics of programming. These findings align with Passey's (2017) argument where he says that the school curriculum in several countries seems to focus on applications such as Microsoft Office. It is also consistent with the work conducted by Carter (2006) which found that there was a lack of education in computing at school. Only a few of the students surveyed in her work had studied something other than computer applications.

Students need to learn more about programming languages and problem solving in a semi-intensive manner to be prepared to study Computer Science at university. The findings of this study indicated that there is a weakness in teaching these important skills at schools, which can build student's experiences and abilities and then motivate them to study this major at university. Interview respondents in Saudi Arabia did not mention a significant amount of programming or problem solving in the computing curriculum. On the other hand, in Scotland a few students indicated a good experience of programming and problem solving at school, assisted by their teachers. The results of the survey confirmed that the proportion of students who learned a significant amount of programming in Scotland was higher than that in Saudi Arabia. This finding is similar to that of Tafliovich, Campbell, and Petersen (2013) who state, based on their experience of teaching the introductory computer programming course (CS1) at university, that many students coming to university had never been introduced to programming, while other students had taken programming courses in high school or were self-taught. This is line with Varma (2009) and Buzzetto-More et al. (2010) where they found in their studies that only a small percentage of the students who study computer science and engineering were motivated by the school's preparation for them to study this field.

By including programming languages and problem solving in the Computing curriculum at schools, this can provide students with a good understanding and knowledge about Computer Science fields.

The current study shows that many students are not aware about the Computer Science field and what it includes before coming to university. As an example, a student stated about the factors that might discourage students from pursuing Computer Science:

"... not knowing exactly what computer science involves, and never had any experience in programming before."

This is consistent with what was stated in the Hur et al. (2017) study, namely that the females' lack of experience and knowledge contributed to a lack of participation, since they found that young females in middle and high schools did not know about Computer Science and what it is about. This makes the stereotyped image in students' mind that the field of Computer Science focuses only on applications. Thus, the Computing curriculum at schools needs to be developed and contain more practices in order to motivate students to study it at university. This argument is consistent with what was indicated in several studies, as the pedagogical practices and practical tasks in Computing subjects are significant in encouraging students, particularly females, to pursue a Computer Science major (Aljughaiman & Ayoub, 2012; Juuti & Lavonen, 2016; Kindsiko et al., 2020; Larsen & Stubbs, 2005).

It can be argued that if schools have developed the curriculum by including new practical skills, this will improve students' experiences in the Computer Science which can influence their decision to study it at university. In this study, during the interviews some of the female students in both contexts asserted that when they were introduced to real programming at university, for example in different courses or in the preparatory year in Saudi universities, they then decided to study a Computer Science major or changed their major to Computer Science. This finding is consistent with studies by Cohoon and Aspray (2006) and Beyer (2014), which found that students' positive experience of Computer Science courses influenced their decision to major in Computer Science or predicted their intention to pursue a Computer Science major. Also, in a study by Margolis and Fisher (2003), females joined the IT field at the university because they had taken and enjoyed programming classes. By teaching programming in high school, participation and persistence in Computing-related majors can be increased (Weston et al., 2019).

The students in both contexts of this study suggested developing the school curricula by adding more programming and problem solving rather than focusing on applications. In Saudi Arabia, in particular, students said that the Computing curricula at school did not prepare them for the major at university. Many mentioned that the programming experience at school was relatively straightforward. Related to this were the findings that Computing experiences during the preparatory year[7] in Saudi universities and students who changed their major at Scottish universities after experiencing computing in associated classes influenced their choice of a Computer Science major. Strengthening the school curricula not only helps students understand the content and value of a Computer Science major, but it also helps prepare them for university study and can inspire more females by letting them see the true nature of Computing fields.

Students also can gain experiences at schools through studying some STEM subjects that partly related or connected to Computing fields such as Maths. In other words, the

[7] A foundation year at Saudi universities must be taken after high school studying general courses, such as Computing and English, as pathways to their major.

interest of students in choosing the Computer Science field at universities can be increased because of studying Maths. This was found in this study and is consistent with previous findings (e.g. Chachashvili-Bolotin et al. (2016), Nugent et al. (2015), Legewie and DiPrete (2014), and Fouad and Santana (2017)) about the positive influence of the STEM learning experience on students' interest in pursuing STEM fields. Many students in both contexts stated that Maths was their favourite subject at school; thus, they chose Computer Science as a practical major related to Maths. This is in line with other findings from the literature, such as Varma (2009), in which most students believed that they were somewhat prepared for studying Computer Science because of Maths courses at school, as well as Hewner and Mishra (2016), who found that there was a relationship between the interest in Maths and the choice to study Computer Science. In addition, there is a positive association between achievement in Maths in high school and the interest in pursuing STEM majors in higher education (X. Wang, 2013). For example, in Saudi Arabia, only students who have studied science subjects at secondary schools can pursue STEM majors at university. Thus, all Computer Science students at university in Saudi Arabia were exposed to science subjects, such as Math, Physics, and Computing.

Some students might have a negative experience from schools which related to class environment. This issue may influence their choice to study Computer Science major. The gender gap in Computer Science seems to start in high school in Computing subject classes. This can be observed in the educational system that has mixed genders and studying Computing subject is not compulsory. This point can be clearly confirmed by looking at both educational systems in Scotland and Saudi Arabia. For example, in Scotland, some students stated that the majority of students in their Computing class were males. This is consistent with Sapna Cheryan et al. (2016), who asserted that there is a gender gap in some science subjects at high school, such as Computing and Physics, but not in other subjects like Biology and Chemistry. For example, during the interviews a female student said "*I was the only girl*" in the Computing class, and in the survey in Scotland another said "*… the gender gap in classes in school*" seems to be a factor that discourages females from pursuing Computer Science at university.

Moreover, as cited in Sapna Cheryan et al. (2016), freedom of choice of subjects at high school, and the requirements determining which subject choices were mandatory or optional, could be a reason for the gender gap in high school. A student in the Scotland context mentioned in the survey: *"... not being able to take it as a school subject because it's in another column with another science so they pick the other science."* Therefore, the gender gap in computer science major at Scottish universities occurred. On the other side, in Saudi Arabia, the educational system is single-gender, there is no mention of the gender of students in the class and Computing subject at schools is compulsory while in Scotland it is optional. Therefore, there is no gender gap in Computer Science major at Saudi universities. This could be one of the possible explanations of female participation in Computer Science in Saudi Arabia, as they do not consider the Computer Science major to be male-dominated (discussed later in relation to perception). Gürer and Camp (2002) stated that if IT classes are male-dominated, that could make them unattractive for females. Also, some studies reported that single-gender IT classes provide female students with relaxing and more pleasant learning environments (Craig, 2005; Leech, 2007; Papastergiou, 2008).

Informal Learning

The second way that can be used by students to build their experiences is self-taught and online courses. The findings of this study found that most of students in Scotland, particularly males, learn by self-taught and online courses, while students in Saudi Arabia and females in Scotland, only learn at schools. During the interviews, a few students in Scotland stated that they had an internship in the computing field. At the same time, no one from Saudi Arabia mentioned internships during the interviews. The survey result has confirmed this point about the internship for both contexts. Therefore, students need to pay more attention to informal learning methods to improve their experience to pursue their studies in Computer Science or other majors.

According to the previous discussion about these two ways of improving students' experiences, it can be argued that prior experience can influence students to choose their major at university, particularly Computer Science. Cohoon and Aspray (2006) argue that computing experience, either formal or informal, will give students initial impressions and information about Computer Science and what they involve. However, its influence might differ from student to another and from educational system to another. To increase the influence of students' experiences, decision makers need to review their educational systems and how they can improve them. This review includes the Computing curriculum and class environment. For example, in Scotland, they can make Computing a compulsory subject at schools and add more practical skills to it such as programming languages and problem solving. Making the

Computing subject compulsory could change the gender gap in the class and will not be male-dominated. Consequently, this can motivate females to participate and enjoy studying this subject at school. In Saudi Arabia, they need to add more practical skills to improve students' experiences in programming and problem solving. Increasing student enrolment in upper secondary school science and technology courses could be achieved through improved pedagogical practices and practical tasks (Juuti & Lavonen, 2016). Also, Kindsiko et al. (2020) showed a significant pedagogical lag in Computing subjects compared with subjects like physics, maths, and biology. An example of what was mentioned by some students regarding Computing subject in Scotland:

"*… if they could make it as important, if they could promote it as much as they promote Physics, Chemistry and Biology or Mathematics, if they could do the same with Computer Science, I think that will do the work.*"

Regarding students themselves, they need to develop their skills, knowledge, and abilities in the Computing field particularly and other areas generally. This can be achieved by attending workshops and courses to learn more knowledge, skills, and experiences and not relying only on school learning.

The influence of prior experience on the students' decision to study Computer Science at university was variable. These experiences and their impact might differ from one student to another or from one educational system to another. Indeed, as found in both phases of the research and according to the SCCT, prior experiences can prepare and motivate students to study Computer Science at university.

To conclude, the importance and value of a Computer Science education is recognized by the Department for Education in England: “A high-quality computing education equips pupils to use computational thinking and creativity to understand and change the world. Computing has deep links with mathematics, science, and design and technology, and provides insights into both natural and artificial systems. The core of computing is computer science, in which pupils are taught the principles of information and computation, how digital systems work, and how to put this knowledge to use through programming” [8] (Department for Education, 2013)

6.2.2 Social Support

This section discusses the support and encouragement which can be received from others, such as parents or teachers and influence the students’ decision to study a Computer Science major at university. According to the SCCT, social support and encouragement from others such as family and school can play an important role in the decision of students to study Computer Science at university. In this study, during the interviews, most of the students in Scotland, and females in particular, reported the encouragement they received from different sources, such as teachers and friends. In the survey, many of the students in Scotland confirmed that they received encouragement from parents and Computing teachers. Also, the proportion of students who received encouragement from friends or from one of their high school teachers was higher than in Saudi Arabia. Family and school can play an important role in the decision of students to study Computer Science at university. Thus, family can

[8] https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study/national-curriculum-in-england-computing-programmes-of-study

encourage their sons and daughters to study Computer Science because they understand the importance of this major for their future. Likewise, teachers at schools can encourage and support students based on their experience. They can explain to students how computing fields can benefit them by giving them the opportunity to get a good and well-paid job in the future. This has been shown by the findings of this study and is in line with previous studies which established the significance of support from parents and family members (e.g. DuBow et al., 2016; Tillberg & Cohoon, 2005; J. Wang et al., 2015). It is also consistent with Teague (2002), who found that the primary factor for females in choosing the computing field was the encouragement they received. Also, Smith et al. (2018) found that both male and female students in Computer Science majors were influenced to make the choice by family and friends.

Some of the students in the interviews stated that their parents and teachers observe their enjoyment and strength in Computer Science, so they encouraged them to pursue it. This indicates the role of the surrounding environment in encouraging students to pursue a Computer Science major, as found in previous studies. For example, Margolis and Fisher (2003) argued that the home environment can lead students to be enthusiastic about Computer Science. Also, Legewie and DiPrete (2014) recommended that expansion of more supportive local environments would increase the proportion of females interested in STEM fields. Thus, encouragement from others may influence a student's decision to pursue a Computer Science major, particularly in the case of females. A student said:

"*I think if they point out your strengths, and what you're good at, I think that makes a real difference. Because I did not really realize it was a strength how much I was* *enjoying it until other people actually said, you are really good at this, and it is kind of makes you happy to solve all these problems. So, I think definitely just recognizing the skill is the important thing."*

It can be argued that encouragement from family, teachers, or friends can be an influential factor for some students, but not for others. During the interviews in Saudi Arabia a few of the students reported encouragement from parents or family members to study Computer Science, while in the survey, some reported receiving support from family, but most said that they had not received such support. This is consistent with El-Bahey and Zeid (2013), who found that social support and role models were not considered the top influences for Computer Science students in Kuwait. In addition, support from others (e.g., parents and peers) was not a significant factor for Computer Science students in the Republic of Armenia and Serbia (Gharibyan & Gunsaulus, 2006; Mirjana et al., 2010), and was not a motivational factor for Computer Science students at a university in Estonia (Säde et al., 2019). Heinze and Hu (2009) also found that support from family and friends was not a powerful factor affecting the intention of students to pursue the study of Information Technology.

It is also argued that female role models in Computer Science fields might encourage and inspire more females to pursue a Computer Science major. The existence and visibility of females in some STEM fields is lower than in other fields such as Biology, so there is a lack of female role models in Computer Science (S. Cheryan et al., 2015). These role models can be academic staff, alumni students, current students, or others who have studied Computing fields. They can encourage and motivate females to study Computer Science by giving exciting workshops and lectures at schools to show them the importance of this field and how it will benefit them in the future. This might motivate students, particularly females, to study Computer Science at university. In this study most of the students in Scotland mentioned the role model as a factor that could encourage females to pursue Computer Science, in suggestions such as "*… more female faculty members. I didn't have a single female lecturer for my first two years of undergrad"*. This suggestion is consistent with other studies which found that role models positively influenced students' decisions to major in Computer Science or attracted females to Computer Science (Amelink & Creamer, 2010; Beaubouef & Zhang, 2011; Beyer & Haller, 2006; Black et al., 2011; González-Pérez et al., 2020; Shin et al., 2016; Varma, 2010b). It has been suggested that showing students female role models, for example by attending the Grace Hopper Conference, could change the stereotypes about Computer Science and enhance the numbers majoring in it (Alvarado & Judson, 2014). This is similar to the case in Saudi Arabia where female students see a lot of females in the Computer Science field and where it is not considered a masculine field. Malaysia and India are other countries where a Computer Science major offers many female role models and it is not a male-dominated field (Mellström, 2009; Varma, 2009).

An interesting finding of this study is the influence of teachers' encouragement on female students in Scotland. For instance, a female student in Scotland said:

"I did ask my Maths teachers in high school that I wanted to do something related to Maths, but not Maths and not any engineering and they suggested Computer Science. And that is when I chose the subject the year after, to do Computer Science."

It was found that many females in this study, particularly in Scotland, received encouragement from others. These findings seem contrary to those of Varma (2009), who found that teachers rarely encouraged female students to choose a Computer Science major, in contrast to the male students who were encouraged to choose Computer Science. Kahle and Schmidt (2004, p. 83) also concluded: “It appears that most women are not encouraged by others to pursue a computer science career”. In addition, family encouragement for females, particularly in Scotland, differs from what was found in other studies such as Tzu-Ling (2019) and Tao et al. (2020), who stated that families support and encourage males more than females in technical fields. One possible reason for this difference is that this study involved only females studying Computer Science at university. It is possible that others were not encouraged and therefore did not choose to study Computer Science and were therefore not included in this study.

Beyer and Haller (2006) highlighted the importance of female computing teachers in influencing female students to pursue Computer Science. In the interview study in Scotland, if participants mentioned the support given by teachers, they were asked the gender of the teacher. For this small number of interview participants, the teacher’s gender did not seem to influence their choice to pursue a Computer Science major. In Saudi Arabia, since the education system is based on the single-gender school, there was no mention of the gender of teachers.

It can be argued that encouragement from others can provide crucial motivation for students to pursue Computer Science at university. Social support can play an important role in influencing students to choose to study a Computer Science major.

In this study, this was found to be particularly true for females in Scotland, as many stated that they were supported and encouraged by others. By assuring the existence and continuation of support, either from family or school, the number of females in Computer Science fields should increase. Also, the presence and visibility of more females in Computer Science fields seems to play a positive role in attracting more females to the field.

6.2.3 Self-efficacy

This section discusses individuals' judgement of their beliefs and capabilities in Computer Science -related tasks and skills, a factor termed "self-efficacy". According to Social Cognitive Theory people can achieve tasks based on their abilities (Bandura, 1986), and self-efficacy is a major variable in SCCT. In this study most of the students expressed confidence in their capabilities when they chose to study a Computer Science major. This argument aligns with previous studies in which students' high self-efficacy led to participation and persistence in their major and their career (e.g. Correll, 2004; Pajares, 1997; Schunk & Pajares, 2005). This confidence was due to skills and background in topics that were studied and learnt at schools, or by being self-taught, or from online courses.

Based on the findings of this study students can be motivated to study Computer Science at university by having strong skills in Computing and Maths, by using technology in their daily life, or by having an interest in creating and designing new things. These skills and interests could lead to a high level of self-efficacy for the students to pursue Computer Science. He and Freeman (2010) and Fan and Li (2005) argued that both knowledge and prior experience influenced self-efficacy. Also, von Hellens et al. (2003) found that prior Maths and programming experiences and accomplishments, as well as students' beliefs about their Maths and programming capabilities, can influence the student's pursuit of a major in Computer Science. Therefore, skills and prior achievements in Maths and Computing play an important role to improve students' self-efficacy in Computer Science.

Playing video games also can improve students' self-efficacy which leads to motivate them to study Computer Science. According to the findings of this study, most of the male students in both contexts seemed to be motivated by playing video games, which did not motivate the female students in either context. This is consistent with Carter (2006), who found in her study that the top reason for male students to choose Computer Science was their interest in computer games, but that this was not the case for females. Also, it is compatible with the findings in Lee (2015) about frequent use of video or computer games, which was strongly linked to STEM major choices for students in tertiary education. In this study, the percentage of males who learned by themselves and enjoyed video games were much higher than that of females. These appeared to be two factors that specifically interested males in pursuing a Computer Science major. It is not apparent that there are lessons associated with either of these findings that could influence female interest in Computing.

As shown in the findings of this study, the confidence of students seems to be high. However, these findings are not consistent with Beyer (2014) and also Beyer and Haller (2006), where they found that females in a Computer Science major had less confidence in their computing skills. This is in line with the Google (2015), Lehman et al. (2017b), and Völkel et al. (2018) studies which reported that female students usually feel less confident in their abilities or rated themselves less in Computer Science subjects based on their skills. Although they expressed low confidence, they pursued the Computer Science major. So, it is important to encourage females and highlight their abilities.

In contrast to some previous research findings, most of the female students in this study appeared to have confidence and belief in their ability to study a Computer Science major. A few of them expressed a lack of confidence in their ability before the beginning of their study, but this feeling seemed to fade when they started studying the major. Previous findings have shown that there is a tendency for females to have a lower self-efficacy than their male counterparts, though this is often misplaced (Huang, 2013; Lehman et al., 2017a; Völkel et al., 2018). It is possible that the higher self-efficacy here was a consequence of the fact that the participants had already chosen to study computing and were currently at some stage of their major. This may have given them confidence that they could succeed in the study of Computer Science. This finding could suggest the benefit of giving females an early opportunity to explore computing to help increase their confidence prior to choosing a major.

Furthermore, verbal persuasion, which refers to encouragement from others, was a potential source of self-efficacy for some students, which is compatible with Bandura (1977). As discussed in the social support section, some students during the interviews mentioned parents or teachers who observed their skills in computing and how good they were at it. Persuasion, therefore, seems to play a significant role in building students' confidence.

The importance of having some skills in Computing before choosing to study Computer Science at university can be debated, as some of the students in this study had little experience or skills in Computing fields before studying Computer Science at university. On the other hand, most of the students agreed on the importance of a passion for studying Computer Science. According to The Collins Concise Dictionary of English, as cited in Oliver and Venville (2011), passion is "a strong affection or enthusiasm for an object, concept, etc.". An emotional response to something might be considered passion (Koballa Jr & Glynn, 2013). As mentioned in the literature review chapter, self-efficacy is about feelings and confidence. For these reasons, when participants in this study stated that they had a passion for computing, it was considered within the self-efficacy factor of SCCT. So, the passion for studying Computer Science major is an influential factor regardless of possessing Computer Science skills before university. Some male students in both contexts mentioned passion as a factor that could encourage males to choose Computer Science, for example:

"*I believe that the only way people can be encouraged to study something at university is when they already have a passion for the degree.*"

High confidence in abilities and skills and the passion for students could encourage them and lead them to choose the Computer Science major. Thus, self-efficacy is an essential factor that influences students to pursue Computer Science major.

6.2.4 Outcome Expectations

This section discusses the outcomes students expected from choosing to study Computer Science at university. Outcome expectation is considered one of the important variables in SCCT and can influence the decision to follow an academic path. According to the findings of this study, it can be argued that the expected outcomes from studying Computer Science include career options and gaining knowledge and skills from this field.

According to the findings of this study, during the interviews, the majority of students in both contexts mentioned the career path associated with a Computer Science degree as a reason to study Computer Science major. This seems to be the result most expected by students who choose to study Computer Science. This path includes getting a well-paid job, finding a job easily, and having many job opportunities. The survey also confirmed that getting a well-paid job and having many job opportunities was important for both genders in both contexts. In addition, most of the students in both contexts stated that the career options were a factor that could encourage males and females to choose to study a Computer Science major. This finding is consistent with other studies that found that career and potential earnings are the main reason for selecting a Computer Science major (El-Bahey & Zeid, 2013; Funke et al., 2016; Hewner & Mishra, 2016; Varma, 2009; Yasuhara, 2005). Furthermore, some students said that they chose to study a Computer Science major instead of their favourite subjects, such as History or Art, due to the career path linked with a Computer Science degree. This is consistent with previous studies’ statements on the career opportunities in computing fields, so that seems to be an influential factor leading students to choose a Computer Science major. Jobs availability and potential earnings give a Computer Science major a career advantage over other majors (Yasuhara, 2005). Also, earnings in engineering and computing outpace other fields (Carnevale, Strohl, & Melton, 2013).

Computer science is considered one of the vital majors that contain the knowledge and varied skills provided to the students. Therefore, an expectation from studying the Computer Science major, which students mentioned during the interviews, is the prospect of gaining more knowledge and skills in Computer Science fields. Most students confirmed this in the survey, particularly in Scotland. This is consistent with Völkel et al. (2018), where they found that students who pursue Computer Science expected to gain advanced technical knowledge and practical skills. The value of Computer Science education and the benefits of a Computer Science major seemed to be important for the students, one of whom stated:

"I think it gives you skills that put you in a very good position. I think it just gives you very useful skills that really put you ahead in life."

It seems that the practical part of the Computer Science major attracts students to decide to pursue it. This is noticeable in this study; some of the students mentioned that they were drawn to Computer Science as it has a practical side rather than other theoretical majors. This is consistent with Teague (2002), who found that female students decided to study Computer Science because of being attracted to the practical side of computing. Also, Carter (2006) and Larsen and Stubbs (2005) found that females chose Computer Science because it could be used and integrated with other fields. In this study numerous quotes supported the practical side of computing, such as:

"I loved Maths but didn't want to do a straight Maths degree so thought I could use those Maths skills in a Computer Science degree."

"Computer science is applicable in many subjects so with a Computer Science degree I can still work with Biology e.g., in Bioinformatics."

It is noted that some students, particularly females, would like to integrate their favourite major with a Computer Science major. This consideration could help in attracting more females to Computer Science (P. M. Alexander et al., 2011). To increase female representation, Computer Science and its related disciplines need to adopt new marketing strategies. For example, nowadays some universities around the world offer some majors which integrate the Computer Science field and others such as health and education. These majors are provided by departments of Computer and Information Sciences and focus on how to employ technology in education, or health, and how to gain benefits from these combinations. Also, Carter (2006) and Larsen and Stubbs (2005) found that females chose Computer Science because it could be used and integrated with other fields.

Helping society was one of the expected outcomes mentioned by a few of the students in the interviews, although it had less support in the survey than other possible expectations. These students thought about how society could benefit from their studies and their potential to contribute to their society. The findings of this study confirmed that and is in line with Margolis and Fisher (2003) where they indicated that several females chose a Computer Science major in order to use or connect it to other areas that benefit the society. It was also found in the Blum et al. (2007) study that female students described their reason for choosing a Computer Science major as a desire to make a major impact on their country or globally.

Consequently, these findings partially fit with Bandura's (1986) categories of outcome expectations. Bandura's outcome expectations fall into three categories: physical, social approval and self-satisfaction expectations. Job satisfaction from a Computer Science degree is seen as self-satisfaction. Gaining knowledge of the Computer Science field may be motivated by future financial or societal rewards. Helping society is closely related to societal approval. Physical expectations relate to the performance of the body, which does not apply to the expectations in this study.

It is recognized that the students' expectations from studying a Computer Science major in this study are generally positive; this may be due to the fact that the sample in this study consisted only of Computer Science students. So, there do not appear to be negative expectations in this study, but the case might be different if students from other majors were included. As cited in Shoffner et al. (2015), counsellors and educators should be aware of negative expectations, because some of these are misguided or illogical, but may still influence students' choices. Thus, it can be argued that the positive expectation can be an important factor in motivating students to pursue a Computer Science major.

The outcome expectations that were expressed by the students in this study can be summarized in the following outcomes: the career path linked with a Computer Science degree, gaining more knowledge of the Computer Science field, and, for a few, helping society. In the survey, there was a question about the expectation that most influenced the choice to study Computer Science. The most influential outcome was different in the two contexts. In Scotland, gaining more knowledge and skills in the fields of computing was the most influence outcome, while in Saudi Arabia, the most influential outcome was having many job opportunities.

6.2.5 Perception

Perception refers to how society perceives students who study Computer Science at university. This concept has arisen from the data during analysis. Thus, it is important to integrate it with other variables of SCCT to investigate the factors that influence students, particularly females, to study Computer Science at university. Perception of a discipline and associated careers is considered a factor that could influence students towards choosing an educational path (Pappas et al., 2016). Since this study was designed to investigate the factors that influenced students, particularly females, to study Computer Science, it is important to find out the students' opinion as to how society perceives them. In investigating why so few women enrol in Computer Science, Varma (2010b, p. 304) stated that: "It is important to get students' thoughts and impressions on the challenges women face to enrol in Computer Science". According to findings of this study, perceptions have two directions positive and negative. In the positive direction, society perceives students who study Computer Science as smart, successful, wealthy, and they have many opportunities to get a job. This perception may motivate students to study Computer Science at university. With regards to negative direction, society perceives Computer Science field as a male-dominated and students who study this major are perceived as nerd or geek. For example, in Saudi Arabia, students did not mention any negative stereotypes of Computer Science students, particularly females and there is no negative perception from the society. Thus, there is no gender gap in the Computer Science major at Saudi universities. This is similar to the case in other countries, such as India and Malaysia, where the Computer Science major is gender-balanced and not considered a male dominated field. The Computer Science field in India is seen as friendly, attractive and suitable for females (Varma, 2010a). In Malaysia females are well represented in the Computer Science field, accounting for over half the students in computing related majors. Often, female students and lecturers dominate the Computer Science fields (Mellström, 2009; Powell & Chang, 2016). According to Othman and Latih (2006), there is no gender bias in the way young Malaysians perceive Computer Science. There is a difference between males and females in computer experience and skills before starting the undergraduate major in computing, but this does not prevent females from excelling and being among the higher achievers in computing fields in Malaysia (Othman & Latih, 2006). The participation of females in Computer Science fields is associated with cultural and environmental circumstances. Blum et al. (2007, p. 2) suggest that "under specific cultural and environmental situations, women fit very well into Computer Science". In Malaysia, many parents motivate their daughters to study Computer Science, and many of them follow their parents' advice, even if other majors are favoured (Lagesen, 2006).

In Saudi Arabia, Computer Science also is considered a top major along with Engineering and Medicine. For example: "*I think the society is proud of Computer Science students, and a Computer Science major is considered as one of the highest* *standard majors such as Engineering and Medicine*". This positive view of Computer Science major in Saudi Arabia or other countries such as Malaysia may be a reason that motivates the females to pursue the major. As mentioned, earlier, the education system in Saudi Arabia is single-gender, so the Computing class at school or Computer Science departments are full of female students and staff.

In Scotland, most of the students (both males and females) stated that perceptions are considered as an influential factor that discourages females from studying Computer Science at university. During the interviews the students in Scotland recognized that society may still have quite a negative view of Computer Science students, which could be off-putting for female students in particular. Some students during the interviews stated that society had a stereotyped view of Computer Science as a male subject; for instance: "*There are stereotypes regarding Computing, that it's a man's subject and women should not do it"*; another said: "*It's just because of the same societal thing that computers are for males. That is what society thinks".* This is consistent with Beyer (2014), where it is argued that numerous studies find that the Computer Science stereotypes are quite negative, especially towards females. Moreover, According to Cundiff et al. (2013), a stereotype of the Computer Science major as a male-dominated major may still positively influence the female's persistence in and choice of a Computer Science major.

In the survey there were some interesting differences of opinion amongst the genders and the contexts. In Scotland both genders agreed that society encouraged males to study Computer Science, but a high proportion of the females disagreed that society encouraged females to study Computer Science at university. On the other hand, in

Scotland, males suggested that society did support females in studying Computer Science. In Saudi Arabia, both genders agreed that females were encouraged to study Computer Science but did not agree that males were encouraged.

Some literature argues that the negative stereotype of Computer Science could affect the choice of females to pursue a Computer Science major if they have a sense of not belonging to the field. It was found that social stereotypes of females in Maths-related fields were discouraging and prevented a sense of belonging to the field (Drury et al., 2011). Others have found stereotypes of the Computer Science major as a masculine field (Cundiff et al., 2013) or as a geeky field (Mikesell & Rinard, 2011; Singh et al., 2007). In addition, there are other stereotypical images of Computer Science students, such as being nerdy and non-social, and these negative stereotypes could also deter students, especially females, from majoring in Computer Science. For example, a study by Sáinz and López-Sáez (2010) found that female students in their investigation viewed computer scientists as socially isolated, and technology and computers as incompatible with social skills. Also, the image of the computer scientist as nerdy was found to be a factor which could deter women from pursuing a Computer Science major (Bock et al., 2013; Burge & Suarez, 2005).

It is important for society, including educators and family members, to know about the effect of these negative views on Computer Science students. They can promote the more positive stereotypes and images of Computer Science that seem to prevail in Saudi Arabia, which could help to attract more females to pursue a Computer Science major. In the present study, it was clear that students saw these negative stereotypes as outdated and exhibited a much more positive view of themselves. This is consistent with the finding of Lewis et al. (2016, p. 30) that: "… some students were able to reject stereotypes about what was required to be a computer scientist, particularly when provided examples of computer scientists who themselves did not match these stereotypes".

6.3 Expanded SCCT with Perception

SCCT was chosen as a theory to underpin the research based on a review of the literature. In particular, numerous recent studies have used SCCT to investigate factors similar to this study. The academic choice model within SCCT theory was used to design both the interview questions and the survey questions. The interview questions were therefore derived using the four main factors from the SCCT academic choice model: outcome expectations, self-efficacy, prior experience, and social support. The interview also contained an additional question to explore any other factors that participants might consider relevant. Additionally, the semi-structured interview allowed the interviewer and participant to further explore any additional topics that might emerge during the interview. In analysing the interview data one additional theme arose where responses could not be categorised within the four SCCT academic choice factors - that of perceptions of computing held by participants, their family, and society more generally. Additionally, interview participants also identified a variety of useful suggestions that might be used to increase female participation, these were not categorised as a factor affecting participation.

After the importance of perception was discovered, the literature was revisited to explore alternative models that might include perception. The TRA model included an attitude factor which is similar to perception, but TRA does not include the other four SCCT factors that had already been demonstrated to be useful during the interview phase of research. The survey phase of research was therefore once again based on the SCCT academic choice model, together with questions based on the additional perception factor, suggestions for improving female participation, and the option to include any further participant thoughts not covered by these topics. The sub-themes identified in the interview study allowed more refined questions to be explored in the survey based on these sub-themes.

Overall, the academic choice model of SCCT was found to be very useful for this research. Its use in previous, related research suggested that this could be the case. It provided a very good basis to design the interview questions, using each of the four main factors as topics for interview discussion. It was found that almost all the responses from participants could be categorised within the four factors and sub-themes of those factors.

One additional factor was identified, that of perception. It is possible that perception may be a specific factor associated with this particular research topic - students' perceptions of computing may play a particularly strong role in choosing which major to study.

SCCT, together with perception, provided a solid base for the design of the survey study. As with the interview data analysis, using a much larger subject base, it was found that all key responses could be categorised within the SCCT plus Perception model. It was therefore found that SCCT together with a perception factor was a strong basis on which to design a study such as this, used as a basis both for the design of the interviews and surveys, as the basis for the data analysis of the results, and for the structuring of discussion and presentation of key findings. It was not found that the SCCT plus Perception model required any further enhancement to capture the factors that emerged from these studies.

The design, implementation and findings of this research therefore suggest that SCCT (supplemented with a perception factor) has been a highly useful and appropriate lens through which to study female under-representation in Computer Science.

6.4 Comparison Between Scotland and Saudi Arabia

This subsection discusses some differences and similarities between students is Scotland and Saudi Arabia. A significant amount of programming at school was mentioned by students in Scotland. Most students in Saudi Arabia and females in Scotland reported that they did not learn computing outside the school curriculum. An internship with computing fields was mentioned by students in Scotland only. In both contexts, many students stated that Maths was their favourite subject at school, and they chose Computer Science as a related and practical major for Maths. The underrepresentation of female students in Computing classes at school was revealed by students in Scotland only. The Computing subject is optional at school in Scotland, whereas it is compulsory in Saudi Arabia.

Most of the students in Scotland, and particularly females, reported the encouragement they received from different sources; this does not look similar to the case for Saudi Arabian students.

Most of the students in both contexts confirmed that they have good skills in some subjects, such as Maths, which motivated them to study Computer Science major. At the same time, most of the male students in both contexts were inspired by playing video games. The proportion of confident students in both contexts, and for both genders, in this study is high. However, some of the female students in Scotland were unsure about their ability to study Computer Science before coming to university, but their confidence seemed to increase when they were at university. Getting a well-paid job and to have many job opportunities with a Computer Science degree was significant for both genders in both contexts. The outcome expectation seems similar in both contexts. The perception of society toward females taking a Computer Science major, in Scotland in particular, may still have a negative influence. In contrast, in Saudi Arabia, there seems to be a positive view, and the Computer Science field is not considered to be male-dominated.

6.5 Answers to Research Questions

This chapter concludes by answering the research questions for this study.

1) What is the role of prior experience in computing in influencing students' choice to study a Computer Science major?

The role of prior experience in computing seems to have no strong influence on students' choice to study a Computer Science major. Most of the students in this study studied a Computing subject at school, but the Computing curriculum at schools appears to have a limited influence on the decisions of students to pursue a Computer Science degree. This is revealed in the responses in both phases, as some students in both contexts blamed the school curricula and suggested updating the Computing subject and making it relevant to the Computer Science major. So, the school curriculum could discourage students from pursuing a Computer Science major, as it seemed to focus more on applications, as stated by most of the students, particularly in Saudi Arabia. In Scotland, some of the students reported a significant amount of programming at school, which was not mentioned by Saudi students. Students in Saudi Arabia reported that Computing at school did not help to prepare them for the Computer Science major. Female students' underrepresentation in Computing classes at school is revealed by students in Scotland only. The Computing subject is optional at school in Scotland, whereas it is compulsory in Saudi Arabia. However, good background and interest at school in Maths, which is related to computing, seems to play a role and may be an influence on students' choice to major in Computer Science, as demonstrated by a number of students in both contexts. Experience outside the school curriculum could also be an influence, as stated by a number of male students in Scotland, through self-instruction or online courses. The results also indicate, for both contexts, that a positive experience for female students in introductory topics in programming during the early years at university could lead them to consider a Computer Science major. This might be due to the opportunity it gives to discover what a Computer Science major involves; so, providing more programming and problem-solving in school curricula could lead to attracting more females to the Computer Science field.

2) What is the role of social support in influencing students to choose to study a Computer Science major?

The role of encouragement from others in influencing the student's choice to study a Computer Science major seems to be important in this study. The results of the study indicated that most of the students, particularly females in Scotland, received encouragement that motivated them to choose to major in Computer Science. There are many sources of encouragement for students in Scotland, such as parents, teachers, and friends. In contrast, in Saudi Arabia, most students stated that they had not received such support, although a few of them received support from parents or family members. In some cases, the role of the supporters in noticing the students' strengths in and enjoyment of computing encouraged them to pursue a Computer Science major. Also, the support may be provided by role models, as the visibility of females in Computer Science fields could encourage more female students to choose to study Computer Science, as stated by some of the students in Scotland. Saudi Arabia already has many females working in the Computer Science field.

3) What is the role of self-efficacy in influencing students to choose to study a Computer Science major?

In this study, self-efficacy seems to play a role in influencing the student's choice to major in Computer Science. The results indicated that most of the students expressed confidence in their abilities and skills when they chose to study Computer Science. High self-efficacy of students in this study is due to their skills and background in maths and problem-solving, use of technology in their daily life, and an interest in creating and designing new things. Also, verbal persuasion seems to play a role in building students' confidence. Playing video games appears to motivate male students only, in both contexts. Based on the interviews, a few female students in Scotland reported a lack of confidence in their abilities in Maths and Computing. Also, in the survey, some females in Scotland were unsure about their abilities to study Computer Science before coming to university, but the proportion decreased when they were actually at university. According to the results, the self-efficacy level may continue to increase at university for those who pursued a Computer Science major with an initially low level of self-efficacy. The importance of passion for studying a Computer Science major was cited by some male students in both contexts, regardless of prior skills in computing before university. An interest in computing plays an important role in influencing the students' decision to study a Computer Science major, particularly for both genders in Scotland and males in Saudi Arabia.

4) What is the role of outcome expectations in influencing students to choose to study a Computer Science major?

The expected results from studying a Computer Science major seem to play a crucial role in influencing the student's choice to pursue it. The students in this research expected some benefits from a Computer Science major, which were categorized, based on their responses, into career options, gaining knowledge of Computer Science fields, and helping society. Career options involving well-paid jobs and job opportunities are apparently a powerful factor for students in both contexts in deciding to pursue computing. Most of the students in this study stated that they chose to study Computer Science in preference to their favourite field because of the career path expected with a Computer Science degree. The result most expected by the students in Scotland was gaining knowledge and skills in Computer Science fields, whereas for Saudi students, it was the many job opportunities available with a Computer Science degree. However, helping society was mentioned by only a few of the students in this study, so it does not seem to be a major influential factor in pursuing a Computer Science major. The outcome expectancy from studying a Computer Science major is a strong influential factor and plays an important role in encouraging students to choose a Computer Science major at university.

5) What is the role of perception of Computer Science in influencing students to choose to study a Computer Science major?

Perceptions of Computer Science are considered an important factor which plays a role in influencing the student's choice to study a Computer Science major. The results indicated that society's perception of females in the Computer Science major in Scotland, in particular, may still have a negative impact. In contrast, in Saudi Arabia, this seems to be a positive view. Societal differences between the two contexts in this study might affect the stereotypes of females in a Computer Science major. The negative perception could discourage females from pursuing a Computer Science major, as stated by most of the students in Scotland. However, the students in this study saw this negative view as outdated and displayed a positive view of Computer Science students and the major. They themselves did not consider negative views when they decided to choose a Computer Science major. So, perception could play a considerable role in influencing the student's choice to major in Computer Science, especially in the case of females in Scotland.

Moreover, the students in this study offered interesting suggestions, which may contribute to preparing students and attracting more females to major in Computer Science fields. The suggestions for school which were mentioned by the students in both contexts were similar, mainly to make the computing subject more practical, with more programming included. Making the Computing subject compulsory was mentioned by the students in Scotland only. Suggestions made in Scotland to increase female representation included: more visits and talks to schools from females in Computer Science, particularly from role models, and more promotion and advertising of the Computer Science major, such as open days especially targeted at females.

6.6 Chapter Summary

This chapter has discussed the findings of the qualitative (interview) and quantitative (survey) phases. Each factor was discussed separately with references to the literature. The role of each factor and how that may influence the students' choice was shown.

Prior experience was not found to be a major influence on students' decisions to study a Computer Science major, perhaps because the school curriculum is too focused on applications, rather than on programming and problem solving. Good background and interest at school in Maths, which is related to computing, seems to play a role and may be a possible influence on students' choice to major in Computer Science in both contexts. Female students' underrepresentation in computing classes at school is revealed by students in Scotland. An interest in Maths and experiences outside of school could be an influence, particularly for Scottish males. Good experiences for females in the early years at university seemed to be a positive influence.

Encouragement from others seemed to play a major role in influencing a student's choice. Many of the students in this study, particularly females in Scotland, identified a source of positive encouragement. It was also suggested that increasing the visibility of female role models had the potential to increase female participation.

Self-efficacy seemed to be another important influence. Much of the self-efficacy in this study seemed to come from maths and problem-solving skills, prior use of technology in daily life, and an interest in creating and designing new things. An interest in computing also appeared to play an important role. Also, playing video games appears to motivate male students only.

The expected outcomes from obtaining a Computer Science major were found to be a very strong influence. Many students chose Computer Science rather than a major in their favourite school subject because of the career path offered by a Computer Science degree. Students in Scotland identified the knowledge and skills acquired in a Computer Science degree, while Saudi students emphasized job opportunities.

Finally, students' and society's perception of a Computer Science major and those who study it could be an influence, particularly if Computer Science is viewed as male-dominated. Here there was a major difference between Scotland and Saudi Arabia, since in Saudi Computer Science is not male-dominated. While the students recognized some of these negative perceptions, they themselves saw them as outdated.

Chapter 7: Conclusions

7.1 Introduction

This chapter provides the conclusions of this study, the contribution to knowledge made by the thesis, the limitations of the work, some recommendations, and the directions for future research.

This study has investigated the factors that influence female and male students to choose to study a Computer Science major at university in two different contexts, Scotland and Saudi Arabia. Both males and females were included in this research to obtain a wider range of insights. The aim was to discover the factors that could encourage more females to study Computer Science, particularly in Scotland. This study answers the following research questions:

RQ1) What is the role of prior experience in computing in influencing students to choose to study a Computer Science major?

RQ2) What is the role of social support in influencing students to choose to study a Computer Science major?

RQ3) What is the role of self-efficacy in influencing students to choose to study a Computer Science major?

RQ4) What is the role of outcome expectations in influencing students to choose to study a Computer Science major?

RQ5) What is the role of perceptions of Computer Science in influencing students to choose to study a Computer Science major?

This study used a mixed method approach to achieve its objective and answer these research questions. The mixed methods approach contains two phases – qualitative and quantitative – for collecting and analysing data.

The first phase of data collection in this study used the qualitative approach. In this phase, semi-structured interviews were conducted with 28 Computer Science students from the two contexts. In Scotland the participants consisted of 17 students (11 females, 5 males, and one MX), and in the Saudi context the participants consisted of 11 students (8 females and 3 males). The participants were from different universities. Directed content analysis was used to analyse the interview transcripts. The data were categorized into five themes. Most of these themes were previously identified based on the elements of SCCT and include prior experience, social support, self-efficacy, and outcome expectations. The fifth theme was emerged during data analysis process and was perception. The findings from this first phase were presented in Chapter 4.

The second phase used the quantitative approach in the form of an online questionnaire. There were 192 participants (117 males, 75 females) in Scotland, and 341 participants (84 males, 257 females) in Saudi Arabia. Two types of statistical tests were used. The first type was descriptive statistics, which were used to analyse the data and validate the qualitative findings in the first phase. The second type was a Kruskal-Wallis test which was used to find if the differences between male and female responses in each context are statistically significant or not. The findings of the second phase were presented in Chapter 5. Chapter 6 presents a discussion of the findings of this study from the first and second phases, in relation to previous research.

The following section presents the main findings of this study.

7.2 Main Findings

The following conclusions have been drawn based on the data analysis and findings in Chapters 4 and 5.

In this study the role of prior experience in computing seems to have no strong influence on the student's choice to study a Computer Science major. Most of the students in this study had taken a Computing subject at school, but the Computing curriculum at schools appears to have limited influence on the decisions of students to pursue a Computer Science major. The school curricula seemed to focus more on applications, particular in Saudi Arabia, although, in Scotland, some of the students reported a significant amount of programming at school. Students in Saudi Arabia reported that Computing at school did not help to prepare them for the Computer Science major. Female students' underrepresentation in Computing classes at school is revealed by students in Scotland only. The Computing subject is optional at school in Scotland, whereas it is compulsory in Saudi Arabia. However, good background and interest at school in Maths, which is related to Computing, seems to play a role and may be an influence on students' decision to major in Computer Science, as demonstrated by a number of students in both contexts. Experience outside the school curriculum could also be an influence, as stated by a number of male students in Scotland, through self-taught or online courses. The results also indicate that a positive experience for female students in introductory programming topics in the early years at university could lead them to consider a Computer Science major, in both contexts. This might be due to the opportunity it gave them to discover what a Computer Science major involves; hence, providing more programming and problem-solving in school curricula could result in attracting more females to the Computer Science field.

Encouragement from others in influencing the student's choice to study a Computer Science major seems to play a crucial role in this study. The results of the study indicated that most of the students, especially females in Scotland, received encouragement that motivated them to choose to major in Computer Science. There are many sources of encouragement for students in Scotland, such as parents, teachers, and friends. In contrast, in Saudi Arabia, most students stated they had not received such support, although a few of them received support from parents or family members. In some cases, the role of supporters in noticing the students' strengths in and enjoyment of Computing encouraged them to pursue a Computer Science major. Also, the role of support may be played by role models, as the visibility of females in the Computer Science fields could encourage more female students to choose to study Computer Science, as stated by some of the students in Scotland.

In this study, self-efficacy seems to play a role in influencing a student's choice to major in Computer Science. The results indicated that most of the students expressed confidence in their abilities and skills when they chose to study Computer Science. High self-efficacy of students in this study is due to their skills and background in maths and problem-solving, prior usage of technology in their daily life, and their interest in creating and designing new things. Also, verbal persuasion seems to play a role in building students' confidence. Playing video games appears to motivate male students only, in both contexts. Based on the interviews, a few female students in Scotland reported a lack of confidence in their abilities in Maths and Computing. Also, in the survey, some females in Scotland were unsure about their abilities to study Computer Science before coming to university, but the proportion decreased when they were actually at the university. According to the results, the self-efficacy level may continue to increase at university for those who pursued a Computer Science major with an initially low level of self-efficacy. The importance of having a passion for studying a Computer Science major was expressed by some male students in both contexts regardless of prior skills in Computing before university. However, an interest in Computing also plays an important role in influencing the students' decision to study a Computer Science major, particularly for both genders in Scotland and males in Saudi Arabia.

The expected results from studying a Computer Science major seem to play a crucial role in influencing the student's choice to study it. The students in this study expected some benefits from a Computer Science major, which were categorized, based on their responses, into career options, gaining knowledge of Computer Science fields, and helping society. Career options involving well-paid jobs and job opportunities are apparently a powerful motivating factor for pursuing Computer Science, for students in both contexts. Most of the students in this study stated that they chose to study Computer Science in preference to their favourite field because of the career path available with a Computer Science degree. Another significant result that was expected by the students was satisfaction of the desire for knowledge in Computer Science fields. Regarding the result most expected by the students, in Scotland it was gaining knowledge and skills in Computer Science fields, whereas for Saudi students it was the many job opportunities available with a Computer Science degree. The outcome expectancy from studying a Computer Science major is strongly considered an influential factor and plays an important role in influencing the students to choose this major at university.

Perceptions of Computer Science are also considered an important factor that plays a role in influencing the student's choice to study a Computer Science major. The results indicated that society's perception of females in the Computer Science major, in Scotland in particular, may still have a negative impact. In contrast, in Saudi Arabia, this seems to be a positive view. Societal differences between the two contexts in this study might affect the stereotypes of females studying a Computer Science major. However, the students in this study saw this negative view as outdated, and revealed a positive view, on their own part, of Computer Science students and the major. They themselves did not consider negative views when they decided to choose a Computer Science major. So, perception could play a considerable role in influencing the student's choice to major in Computer Science, particularly for females in Scotland. The design, implementation and findings of this research therefore suggest that SCCT (supplemented with a perception factor) has been a highly useful and appropriate lens through which to study female under-representation in Computer Science. There were interesting suggestions by the students in this study, which may contribute to preparing students and attracting more females to major in the Computer Science field. The suggestions for schools which were mentioned by the students in both contexts were similar: mainly, to make the Computing subject more practical, with more programming and problem solving included. Making the Computing subject compulsory was mentioned by the students in Scotland only. Suggestions made in Scotland to increase female representation included: more visits and talks to schools from females in Computer Science, such as role models, and more promotion and advertising of the Computer Science major, such as open days particularly targeted at females.

7.3 Contribution to Knowledge

The findings from this research add to existing knowledge about female underrepresentation in Computer Science. Knowing the factors that influenced students to study Computer Science can help policymakers to tackle this issue. Moreover, the research involved identifying the factors from the students' perspective in two different contexts. Saudi Arabia has a gender balance in the Computer Science field and the differences and similarities between Saudi and Scotland may help to identify factors which could increase female representation in Scotland. This study contributes to that effort by using Social Cognitive Career Theory (SCCT) (Lent et al., 1994) as a theoretical framework to guide the research and to identify and investigate the reasons that influence students to choose to study Computer Science at university, particularly female students. This research was conducted in two different contexts and collected data from male and female students who had already chosen to study a Computer Science -related major. This led to a wide variety of views and experiences being collected and allowed an international comparison of the factors that could encourage more females into Computer Science fields. The study used a mixed-methods approach starting with interviews with Computer Science students exploring the factors that influenced them to choose a Computer Science major. To further investigate and support the first phase, the second phase then implemented an online questionnaire using a much larger pool of students.

The following is a list of the main contributions to knowledge made by this research.

- An original research study that used SCCT to guide a qualitative investigation of the factors that influence (mainly female) students to choose to study Computer Science at university.
- A first study to investigate factors influencing Computer Science participation in both Scotland (a 'lower' female participation country) and Saudi Arabia (a 'higher' female participation country).
- A key contribution added by this research is that SCCT supplemented with a perception factor was found to be effective in identifying key factors which influence students to choose to study Computer Science in both Scotland and Saudi Arabia. More specifically:
- It was found that the Computing curriculum experienced by participants in both countries had limited impact on the choice to study Computer Science. For females and males in both contexts, maths could be a positive influence. Experiences outside of school could be an influence, particularly for males in Scotland.
- In Scotland it was found that the optional nature of Computing subjects in schools, and the fact that it is male-dominated, could be a strong influence against female participation. In Saudi Arabia Computing is compulsory and

because the education system is single gender, there is no mention of the gender of students in the Computing class.

- Another new finding in this research was the important role that encouragement from others - teachers, parents, friends, family - played in positively influencing female participation, particularly in Scotland.
- The importance of self-efficacy was a further contribution from this research. Most students expressed confidence in their abilities and skills when they chose to study Computer Science. High self-efficacy of students in this research is due to their skills and background in Maths and problem-solving, prior usage of technology in their daily life, and their interest in creating and designing new things. Playing video games appears to motivate male students only, in both contexts.
- A key contribution was related to the SCCT factor outcome expectations. The career paths offered by a Computer Science major appeared to be a strong influence in both contexts - students in Scotland emphasised the knowledge and skills acquired in a Computer Science major, while Saudi students emphasised job opportunities.
- The additional perception factor helped to identify what appears a major difference between Scotland and Saudi Arabia - society's view of those who choose to study Computer Science. In Scotland there still appeared to be some outdated negative perceptions associated with Computing whereas it was much more positive in Saudi Arabia (as it is in other countries with a higher female participation rate such as Malaysia and India).

- It was important that females were over-sampled – this was seen as a strength of this research – as the focus of the work was to discover the influences on females who chose to study computing. However, it was also deemed important to include some males in the study to explore whether there were any noticeable differences in the views between females and males.

With regards to practical contributions, the main contributions from this research which could help policy makers address the gender gap in Computer Science include:

- Recognising the importance of pre-university Computing experiences, for example by providing more support from the surrounding school and home environment and trying to present more positive views from society towards females in the Computer Science field. Schools and families should be made aware of their roles in encouraging and supporting students to pursue Computer Science fields. The results of this study clearly showed the role of the influence of others. One concrete suggestion is to make more use of female role models in visits to schools.
- Universities should develop strategies that could attract more females to Computer Science fields based on the findings in this study, for example by organising University events that are particularly focused towards females, such as open days, talks and other events.
- The negative perception in Scotland around females in Computer Science fields should be changed as this is clearly discouraging. This aligns with previous studies which found negative stereotypes about females in Computer

Science that may influence the choice of a Computer Science major for females (Beyer, 2014; Cundiff et al., 2013).

- The Computing curriculum should be updated to focus more on programming, problem solving and more recent topics in the field. Also, making the Computing curricula at school more interesting would help address some of the negative experiences that may be cause females (and males) not to choose a Computer Science major. Improving skills in topics such as problem-solving and programming, and highlighting students' abilities and strengths, should help increase their confidence (self-efficacy) and may make them more inclined to choose a Computer Science major.
- There were many suggestions to make Computing compulsory at school in Scotland and raising it to the same status as Maths and the Sciences. Not only will this raise the status of Computing but will reduce the potential for female isolation in Computing classes. This is consistent with previous studies suggesting effective ways to increase female participation through the Computing experience in schools (Brown et al., 2013; Hur et al., 2017).
- A major finding in this study was the influence of the expectations and the variety of job opportunities from a degree in the Computer Science field. The Computing industry, in conjunction with schools and universities, should do more to publicise these benefits of a Computer Science major to school children, their families and their teachers.

7.4 Limitations and Suggestions for Future Research

There are a number of limitations that need to be considered in this research which then lead into suggestions for future research:

- The number of participants in the second phase of this study was limited, as the sample is small from both contexts for representing the population of Computer Science majors.
- This study likes other studies is not free from subjectivity and bias which may influence the research processes, such as sample selection, and data coding. However, the researcher has done her best to reduce the possible bias and to be consistent as possible at all stages of data collection and analysis. Therefore, in recruitment stage, both gender (male and female) in Computer Sciences departments were selected to participate in the study. Thus, invitation for participation was sent via email to these departments in Scottish Universities and Saudi Universities. It has been mentioned that the sample used was purposive sample, and the questionnaire was sent by email to Computer Science departments at Scottish and Saudi Universities.
- A potential limitation is the dominance of females in the study. This is clearly out of line with female representation in Computer Science majors, particularly in Scotland. As the main focus of this work was to understand what attracted females to study Computer Science, it was useful to have more females try to get a full range of views on what attracted them to Computer Science and what could be done to attract further females. However, it was

also important to include males in the study to gain a perspective contrasted with that of the females.

- Another possible limitation is that only certain Scottish and Saudi universities were sampled for interviews – three universities in Scotland and four universities in Saudi. It is, therefore, possible that there were different viewpoints amongst students at other universities, some of which could have been missed or over-represented based on the universities chosen for this study.
- Due to data triangulation, and the lack of new responses as further interviews were carried out, there is some confidence that many of the key findings amongst computing students in Saudi and Scotland have been identified. However, it is still possible that important findings have not been uncovered. Students at different universities, students who didn't volunteer, or students who chose a different (or no) degree, may all have additional or different viewpoints.
- The contexts of this study were only Scotland and Saudi Arabia and so the results cannot be generalized more widely. In terms of further research, this study could therefore be replicated in other contexts to obtain further confirmation of the findings and additional insights.
- There was no segregation between different Computer Science related majors in this study. This was valuable to obtain a wide range of views. Future research could focus on students of specific majors and might identify different

insights between different varieties of Computer Science degrees or different universities.

- This study did not include non- Computer Science students. The aim of the study was to investigate the factors that influenced students to choose a Computer Science major. As a result, this study might have produced a more positive view of Computing compared to the views of student who choose not to study Computer Science at university. As stated, Computer Science students were purposively selected to gain insights about their experiences. It is recognised that further studies are required to explore the reasons why students with a potential interest in Computing chose not to select the major, particularly those with an interest in Math, Science or Computing at school.
- This study has not focused on the changes to the Computing curriculum in detail over time. Rather, this study has included students in various years of university study, who may have studied different curricula over their school years.
- There is a need for more investigation of the school Computing curricula and how it can be made more interesting, how it can better prepare students for university computing, and how it can be designed to encourage students, particularly females, to pursue a Computer Science major at university. This research should be both from the teacher perspectives and the school student perspectives, using appropriate research methods for each.
- There is also good potential for further research that focuses on school students, rather than university students, and their experiences while actually

at school, exploring their intention to pursue computing-related majors at university.

- There is potential to use a SCCT-like framework to guide these further investigations.

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Appendix A: Interview Questions

Gender:	Nationality:	Type of school & where:	
	University:	Current Year:	

Factor	Questions
Prior experience:	1. What was your favourite subject at school? (If it was not CS) why did you not choose to study it at university?
	2. When did you start using computers (PC)? 3. What was your purpose for using computers at first? 4. Where did you first use computers?
	5. Tell me about CS subjects studied at school, what aspects did you enjoy? 6. Which aspects did you not enjoy? 7. How many courses did you have in CS at school?
	8. How was the CS class environment for you and for the other students, both male and female?
	9. In your opinion, do you think it is important for everyone to study CS at school? (If yes), Why do you think CS is important at schools? If no, why?
	10. Did you have any programming course inside or outside school? 11. Have you tried to learn programming before university? If yes, how? And where? Which languages?
	12. How do you think these experiences influenced you to study CS? 13. When did you decide to study CS? Was CS your goal from an early stage in school?
	14. Is there anything else you would like to add about your experience in studying CS at school?
Social Support	15. Did you get any encouragement to study CS? if yes: - Who encouraged you? - How did they encourage you?
	16. Is there someone who inspired you to pursue CS? If yes, please describe your experience with him/ her?
	17. In your opinion, how do you think parents or others such as counsellors or teachers can play a significant role to encourage students to study CS?
	18. In your opinion, how can schools support students to study CS as a major at university?

	19. In your opinion, do you think there are differences between genders when getting support from family or society for studying CS?
expectations	20. What do you believe are the potential outcomes of pursuing computer science? 21. What do you expect to do after graduation?
	22. Do you think these expectations can influence students to study CS?
	23. What do you know about possible careers with a CS degree?
	24. Do you think that careers with a CS degree are attractive to women? If yes, why? If no, why not?
Self-efficacy	25. How confident are you in your ability to study CS?
	26. How would you describe your beliefs about computer science as you are pursuing it? 27. How does pursuing computer science make you feel?
	28. Could you tell me about your skills with programming or any related disciplines such as problem solving? How do you think these skills and ability in programming or similar such as problem solving can influence a student's choice to study CS?
others	29. In your opinion, how are CS students perceived by society in general? What do other people think are the characteristics of CS students?
	30. Do you think a CS major is a male dominated major? If yes, why? If not, why not? What might be done to change that?
	31. Do you think there are fewer females than males studying CS major? If yes, why is that? How can universities attract more females to study CS?
	32. Why did you decide to study CS major? Or what was the most influence on you to choose CS?
	33. Is there anything else that you would like to add?

Appendix B: Participant Information Sheet for Interview

Research Title: Exploring the Motivational Factors for Students to Study Computer Science at University in Different Contexts

Investigators:

- Ms Amnah Alshahrani (Computer and Information Sciences, PhD student, amnah.alshahrani@strath.ac.uk).
- Dr Murray Wood (Computer and Information Sciences, Lead Supervisor, murray.wood@strath.ac.uk, +44 (0)141 548 3390).
- Ms Isla Ross (Computer and Information Sciences, Second Supervisor, isla.ross@strath.ac.uk, +44 (0)141 548 3422).

Dear Participant

You are invited to participate in research being conducted by Amnah Alshahrani who is a PhD student at the University of Strathclyde. This information sheet describes the research to be undertaken. Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate or not. If you have any questions about the research, please ask the researcher.

Thank you for participating in this interview. First I would like to let you know that the interview will be audio recorded and may take up to 30 minutes. I will give you a draft of the questions to read before we start. The questions ask about the factors that motivated and influenced you to study computer science (CS) at university. The aim of this study is to explore the role of self-efficacy, prior experience, social support and outcome expectation in influencing a student's choice to study a computer science major at university. You will be identified by ID number (e.g. P1). Your name and other contact details will never be used in this research so that you cannot be recognised from the interview data. The collected data from the interview will be used for research purposes only, and will be stored and kept strictly confidential. An anonymised version of the data will be made available for research purposes only.

Though there are not direct benefits of participating in this study, this interview is an opportunity for you to share insights and stories about factors that encourage students to study a computer science major. The benefit of this study is to inform educational policy makers of these factors, and to inspire more students to study CS, especially females.

You will receive a £5 voucher for Tesco for your participation. Your participation in this research is voluntary and you are free to withdraw at any time without giving a reason.

I will give you a consent form to read and sign.

To protect participants, the following steps will be taken with regards to anonymity and confidentiality of information:

1) The audio recording will be kept on my personal computer for transcription, and then will be deleted after the PhD has been awarded. An interview transcript will be stored on the Strathclyde H drive and external hard drive to be analysed.
2) Digital copies of interview data will be included in the University Knowledge Base. These copies will not contain any information which could possibly identify any participant.
3) The consent form will be kept in my supervisor's office at the University of Strathclyde for five years. When this period is over, this form will be shredded.

Please read the consent form carefully and be confident that you understand its contents before signing it. If you have any questions about the research please feel free to contact the researcher or any of her supervisors.

Researcher	Primary supervisor	Second Supervisor
Ms Amnah Alshahrani Computer and Information Sciences, PhD student amnah.alshahrani@strath.ac.uk).	Dr Murray Wood Computer and Information Sciences murray.wood@strath.ac.uk, +44 (0)141 548 3390).	Ms Isla Ross Computer and Information Sciences isla.ross@strath.ac.uk, +44 (0)141 548 3422).

This study is approved by the Departmental Ethics Committee and if there are any concerns you should contact the Departmental Ethics Committee using enquiries@cis.strath.ac.uk

Appendix C: Consent Form for Interview

Researcher: Ms Amnah Alshahrani, amnah.alshahrani@strath.ac.uk,
Department of Computer and Information Sciences.
Supervisors: Dr Murray Wood, murray.wood@strath.ac.uk,
Department of Computer and Information Sciences.
Ms Isla Ross, Isla.ross@strath.ac.uk,
Department of Computer and Information Sciences.

Title of the study: Exploring the Motivational Factors for Students to Study Computer Science at University in Different Contexts

By signing below, I confirm that I have read and understand the following points:

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask any questions.
2. I understand that my permission is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected.
3. I agree to take part in the above study.
4. I consent to be audio recorded.
5. I consent for anonymised data gathered from this interview which does not contain my identity information to be made available for research purposes.

Name of Participant		Date:	
Signature of Participant			

Name of Researcher		Date:	
Signature of Researcher			

Appendix D: Example of the transcripts

A: Amnah (interviewer)

R: Respondent

A: First of all I would like to thank you for participating in my study.

R: You're very welcome.

A: I would like to ask you just a general question. What's your nationality?

R: Scottish.

A: Okay. Could you please tell me about the type of high school you went to?

R: I did a bit of Computing in high school, and I really enjoyed it.

A: Was that in public school?

R: Yes. It's a public school.

A: In Scotland?

R: Yes.

A: Okay. Are you a first year student?

R: Yes.

A: What was your favourite subject at school?

R: It was Computing.

A: Okay. When did you start using computers?

R: It was probably at home when I was eight years old probably, just using it for fun and communicating.

A: Okay. Could you please tell me about Computing subjects you studied at school?

R: Yeah, it was really good. I had a good teacher who did a lot of extra projects with us, and we got to do a lot of programming. And I enjoyed the way computers kind of worked in a really simplistic way. And we learnt a lot about partly how they were made and partly how we could use them to our full advantage.

A: Okay. What aspect did you enjoy, and what aspect did you not enjoy in Computing?

R: Of the subject in school, I really enjoyed doing the programming, and building my own things. I didn't enjoy kind of learning all the definitions of things, and having to memorise specific aspects, even though they were helpful in doing the programming. I didn't enjoy that quite as much.

A: Okay. How many courses did you have in Computing at school? For example did you have it in S4, S5, S6?

R: I started off doing general subjects, then I chose it straight away from you could choose it. And I did it right up until Higher in fifth year. And I left school after that, so...I probably would have done Advanced Higher

A: Okay. How was the Computing class environment for you and for other students, male and female?

R: It was good, because it tended to be smaller classes, and so we had a lot more discussion and would always be very interactive with the teacher and we would get the chance to practice things. And we got on well and helped each other out, so it was good.

A: Was there any other female students?

R: There was, in my Higher class in fifth year, there was only one other girl. So we were in the minority, but it was still good.

A: Okay. In your opinion, do you think it's important for everyone to study Computing at school?

R: Definitely. I think maybe a few years it wouldn't have been the case, but now, they're more important than ever. And you can't work anywhere and avoid computers. So I think it's really important that everyone properly understands them.

A: Why do you think it is important?

R: Well, a lot of people use them and don't know how they work. And that kind of leads to less and less understanding, and a kind of level of ignorance. So I think if everyone had more knowledge of how they work, then they would be able to use them more effectively.

A: Okay. Did you have any programming courses inside or outside school? Which languages and where did you learn?

R: Well we learned Python as a part of the course in school. It's the only language we really used there. And it's quite a small school, so we didn't have much chance to do electives or other projects like that. But we did a lot of Python, and it was quite good.

A: Okay. Outside school have you tried to learn something else?

R: I went to a college introductory thing with some of the people from my class. And we did a bit of sort of...it wasn't so much programming, but it was problem solving in a way that taught you how to program. But I couldn't afford to go on the full course.

A: Okay. How did this experience with Computing influenced you to study Computer Science major?

R: I think it was partly the she recognised that I enjoyed it. And sort of I was always really interested in the way...I love the way in programming it's about, and you can keep working on that until you finally get the solution. And then you can make it work better and everything. So I liked the kind of challenge that that posed. And yeah, I just sort of, when it came to decide what I should do, I thought "yeah, I really like learning about this and it’s a really important skill to have".

A: Okay. When did you decide to study Computer Science? Was that your goal from an early stage at school?

R: It wasn't so much, I didn't really know what I wanted to do until I got into kind of more advanced subjects, and I worked out I enjoyed sciences, and I worked out that I enjoyed Physics and Computing and I thought "well, there's a lot I can do with that." So I thought yeah, Computing is the right way to go. It was kind of in fourth year that I decided that.

A: Is there anything else you would like to add about your experience in studying Computing at school? Or the curriculum, about teachers, about students in Computing?

R: I think the teacher was always really good with giving us projects, but I think the exam, I think it doesn’t take the full potential of what Computer Science is really about. So it doesn't have as much practical aspects, and it's more about kind of knowledge of everything. And that's not really...Computing's more about understanding and being able to do things and experiment and problem solve. And I think there wasn't as much of that in the assessments as there could be.

A: Okay. Is your teacher male or female?

R: Female. She was the Head of the Computing Department.

A: Okay. Did you get any encouragement to study Computer Science?

R: A kind of, when I mentioned it to my parents, they obviously thought "yeah, that's really good, you're talented at that." And my Computing teacher, she suggested it first. So it was definitely, there was a bit of encouragement from all that.

A: Okay. Is there someone who inspired you pursue Computer Science?

R: I couldn't say any particular person. But maybe my dad, who is a physics and maths person, but he loves messing about with computers and fixing computers, and he was always the one his colleagues would turn to whenever something was broken.

And I think in a way, I'm a little bit like him, and I kind of wanted to do something like that.

A: Okay. In your opinion, do you think parents or others such as counsellors or teachers can play a significant role in encouraging students to study Computer Science?

R: Well, I think if they point out your strengths, and what you're good at, I think that makes a real difference. Because I didn't really realise it was a strength how much I was enjoying it until other people actually said "you're really good at this, and it kind of makes you happy to solve all these problems." So I think definitely just recognising the skill and the motivation you is the important thing.

A: What about counsellors?

R: In a way, when I mentioned anything...we don't have a very high proportion of people going to university, so they were just happy that I had done something that I was really good at. So it wasn't really specifically to Computing, but they did definitely say "well, if that's what you're really good at then we can give you all the help you can get."

A: In your opinion, how can schools support students to study Computer Science as a major at university?

R: I think by encouraging more and telling people more about how it's a bit different in university than in school, how it's a lot more practical, and there's such a wide range of things you can do with Computing. And I think definitely encouraging people, "this is just stuff that everyone deals with, and anyone can do it." And anyone who enjoys problem solving has the ability and motivation to do Computing.

A: In your opinion, do you think there are differences between genders when getting support from family or society to study Computer Science?

R: I think there is a bit in society. I think that now, because of the original imbalance of women in STEM, I think people are encouraging women a lot more to go into it, which I think is a really great thing. And my family did point out that, you know, as a woman in this subject, you have the ability to kind of stand out and do it really well and be recognised for that.

So I think there's a lot more encouragement for women nowadays, but I think they still don't...I think it's part of a problem where girls don't see themselves as being able to do this type of thing. So again I think it's about encouragement, and really telling people "you can do this."

A: What do you believe are the potential outcomes of pursuing Computer Science?

R: I think there's a lot! You'll be better with computers in everything that you do. Like, you'll be the one everyone turns to to fix things, and obviously, all sorts of jobs. Open in computing and science. You can go from designing and building computers to building apps, making software.

You can even go into something that people don't think of as Computing-related, more kind of problem solving and maths things, because you have the ability and the understanding to do Computing. I think it really gives you a lot of options.

A: Okay. Any other outcomes and expectations?

R: You earn a lot of money!

A: What do you expect to after graduation?

R: I don't really know. I don't have any specific plans. Because I'm just at the start, I'm wanting to kind of see where my strengths are, and what particular things I enjoy. But hopefully going to work for a good company in a computer based-subject. And hopefully I'll have a job with freedom in it, to be able to design and create things of my choice and creativity rather than follow set patterns.

A: Okay. Do you think this experience can influence other students to study Computer Science?

R: I definitely think it can. If people properly knew the opportunities you can have with a degree like this, I definitely think that more people go for it. I definitely think Computing's not seen as a valuable enough thing to a lot of people. Yeah, it would be good to help them understand that.

A: Okay. What do you know about possible jobs with a Computer Science degree?

R: I don't know that much, I only looked at degrees before I came, I didn't especially look into jobs. But like I said I know there is a lot out there, and you can do, like I said, you can be self-employed, do your own apps, make your own things. Or you can work for all the companies who are developing computers and computer products and I definitely know there's a lot.

A: Okay. Do you think jobs with a Computer Science degree are attractive to women?

R: I think they can be. I think a lot of women see themselves as not enjoying those type of jobs, but definitely if they gave people that ambition. Well, there's jobs in Computing in all sorts. So if you want part-time, you can do part-time, if you want to be self-employed you can do that, of you want to work for a large company and try and work your way up to the top, then there's definitely that possibility. So I think there's enough ways to go about it that it should be attractive enough to whatever anyone wants.

A: Okay. How confident are you in you ability to study Computer Science?

R: Oh. [*laughs*] Well, after about three weeks of doing it I'm thinking it's a lot of work, but it's work that I'm interested in. So I'm definitely motivated to be able to do it. And so far, I've been managing to keep up and understand everything, and definitely I'm very able to do this when I put my mind to it.

R: Okay, that's good. How would you describe your beliefs about Computer Science as you are pursuing it? Your beliefs about your capability, your confidence...

A: Yeah. I'm thinking to start off with I have fairly basic skills, but I'm going to be able to build them more and more as it goes on. I think I'll be able to do many things by the end of it.

A: Okay. Also, how does pursuing Computer Science make you feel?

R: Challenged, a lot of the time. There's a lot of challenges in it. And that does make me motivated to do more and do better.

A: Okay. Could you tell me about your skills with programming or any related disciplines such as problem solving?

R: I don't have very much ability yet. I can do sort of basic things by myself, but I know I have the ability to learn them very quickly and I understand what they're about. So I think I have the ability to learn fast enough, hopefully.

A: How do you think these skills or ability in programming or similar such as problem solving influence students' choice to study Computer Science?

R: I think some people are put off by the sound of "problem solving", because they think of Maths and kind of difficult things. But a lot of it is just about kind of looking at what you have, and trying to make something out of that. I think if people understood better, they would be a lot more encouraged to do it. And yeah, like you said, a lot of people are put off by a lack of programming knowledge, and I think if they understood that you just need to start with an ability to learn and understand things, then you can really do quite well in a way.

A: Okay. In your opinion, how are Computer Science students perceived by society in general?

R: I think they're really well-respected, because if your computer breaks, you want to be friends with someone who can fix it. And I think definitely, more and more, it is a very desirable position to be in, to be able to properly know how to work computers. So I think it's good.

A: Okay. What do other people think are the characteristics of Computer Science students?

R: I think they think they're quite nerdy, introverted, and kind of prefer computer games to real life sort of thing. Which, you know, typical stereotypes.

A: Okay. Do you think a Computer Science major is male-dominated?

R: Currently, I think it definitely is. There's definitely more men than women in it. But I think that...I wouldn't say "dominated" is the right word, because we're definitely coming up there, and we're doing well in it. So I think there's a majority of men in it, but it doesn't mean they're beating us.

A: That's good. What might be done to change that?

R: I think it starts back at high school when girls think of Computing as a Maths, difficult thing to get your head around, and they think that if they haven't done anything in it before, you can't start now. Which I think ...it's important to encourage people that yes, you can actually do this and that, yeah, they should believe in themselves more.

A: Okay. Do you think there are fewer females than males studying Computer Science?

R: Yeah. I would think so.

A: Why is that?

R: I think partly because of tradition, and men have traditionally kind of done the sciency technology things, and women are just now starting to realise that "hey, we're really good at this too." And I think maybe because we don't see any role models, we don’t see any major women in the kind of industry, and we think "oh well, how can I hope to do well if no-one else has?"

A: How can universities attract more females to study Computer Science?

R: That's a tricky one, because obviously there's programs and scholarships they can do. But that could be just discriminating against men who are really good at it. So I think definitely encouragement is the way to go, and telling the people who are interested in this that they have the ability and that they should be inspired to go into a male-dominated field, rather than be scared of it.

A: Okay. Why did you decide to study a Computer Science major, or what's the biggest influential factor?

R: The most influencing factor I would say is my enjoyment of it, and it's kind of the study-based thing that I enjoy the most. I think that's the most. And I think also the fact that there's plenty of jobs available in it. I'm quite lucky that I enjoy Computing rather than Art, because Art is a lot harder to get a job in at the end, so...

A: Okay. Is there anything else that you would like to add about Computing at school, or about females in Computing Science? Did you try to go to a company and try to work with them, or any program like that?

R: I haven't really had any experience of that yet, but I hope to..

A: Okay. Thank you very much.

Appendix E: Example of qualitative data analysis

Aggregate	Classification	Coverage	Number Of Coding References	Reference Number	Coded By Initials	Modified On

Nodes\\Themes\\Expectations\Job

Document

Internals\\Interviews\\P1-

Aggregate	Classification	Coverage	Number Of Coding References	Reference Number	Coded By Initials	Modified On
No		0.0074	4			
				1	ALSHAHRANI	20/11/2017 11:32

hoped to be able to be qualified for as many jobs as possible in Computing almost.

				2	ALSHAHRANI	20/11/2017 11:32

I want to be able to get a job quite easily out of university.

				3	ALSHAHRANI	20/11/2017 11:33

Just get a job

				4	ALSHAHRANI	20/11/2017 11:33

I was considering taking maybe a postgraduate course

Aggregate	Classification	Coverage	Number Of Coding References	Reference Number	Coded By Initials	Modified On

Internals\\Interviews\\P13

Aggregate	Classification	Coverage	Number Of Coding References	Reference Number	Coded By Initials	Modified On
No		0.0122	1			
				1	ALSHAHRANI	13/12/2017 12:05

Basically, your dreams drive you, whatever you want to become, you would work hard to become that. So if you want to becon
Scientist, you would pursue a degree in Computer Science. So, I think, yeah, expectations play a great role in choosing what you

Internals\\Interviews\\P9

No		0.0353	1

1	ALSHAHRA NI	11/12/2017 09:58

there are two very different reasons for people to study Computer Science in my class. Some people want to study Computer S job, and other people want to study Computer Science because they like it. And there are some people, like those two things, t some point. But yeah, I think there are people exclusively looking for a job, and people who have a lot more interest in what th

Internals\\Interviews\\P10

No		0.0422	4

1	ALSHAHRAN I	11/12/2017 10:(

I knew that Computer Science would give me a more options of jobs, because most jobs involve computers.

2	ALSHAHRAN I	11/12/2017 10::

And I knew, again, that Computer Science would help me with a job.

3	ALSHAHRAN I	11/12/2017 10::

A job that is mixed, because obviously just because I study Computer Science it doesn't mean I have to become a programmer. any job sector, as long as I have something that shows I can, you know, program or whatever, they will see me as useful. So, I th with a good job, and not be stuck in a limited area.

4	ALSHAHRAN I	11/12/2017 10::

Because if you know you want a good job, and you want it to be varied, you should pick Computer Science. There are other sub just Computer Science, but it's one of the ones that will help you get a job quick, because anything computer-related is in high c because of the technology.

Aggregate	Classification	Coverage	Number Of Coding References	Reference Number	Coded By Initials	Modified On

Internals\\Interviews\\P11

No		0.0479	3

1	ALSHAHRAN I	12/12/2017 09:!

I think there's job security, because I think most fields from medicine to banking, aviation, they are in need of Computer Scienti thing, the job security.

2	ALSHAHRAN I	12/12/2017 09:!

I want to work in the Finance industry, but in technology in particular.

3	ALSHAHRAN I	12/12/2017 09:!

Appendix F: A Copy of the Online Questionnaire

Factors that influence CS students to study CS.

Start of Block: Welcome

Welcome! This study is about the factors that motivated and influenced you to study Computing (Computer Science) at university.

Are you currently studying Computing (Computer Science) at university?

○ No

○ Yes

Start of Block: Not Student at CS

Thank you for your time.
This survey is only for students studying Computing at university. You can now close your browser window. Thanks again.

Start of Block: Information Sheet

Dear Participant, you are invited to participate in research being conducted by Amnah Alshahrani who a PhD student at the University of Strathclyde is, Glasgow, UK. This introduction describes the research to be undertaken. Please read this carefully and be confident that you understand its contents before deciding whether to participate or not. If you have any questions about the research, please ask the researcher by emailing amnah.alshahrani@strath.ac.uk **What is this Study about?** The title of this research is “Exploring the Motivational Factors for Students to Study Computing at University”. This research aims to explore the role of prior experience, social support, self-efficacy, and outcome expectation in influencing a student’s choice to study a computing degree at university. The benefit of this study is to inform educational policy makers of these factors, and to inspire more students to study computing, especially females. This study is approved by the Computer and Information Sciences Departmental Ethics Committee at University of Strathclyde and if there are any concerns you should contact the Departmental

Ethics Committee using enquiries@cis.strath.ac.uk The ethics approval number is: 799

What should I know? The questionnaire is completely anonymous and confidential and there is no way to identify who has filled it in. It is asking computing students about their views and experiences of factors that encourage students to study computing at university. This questionnaire will take approximately 13 minutes to complete. Your participation in this research is voluntary. There will be a £10 Amazon gift certificate issued to five randomly selected participants from those who choose to enter the draw at the end of the survey.

What will happen to the data? The collected data from the questionnaire will be used for research purposes. A summary of the findings will be made available for other researchers to use. **Who can access the data?** The data captured from this study may be made available to other researchers.

What is next? It is up to you to decide whether to take part. If you decide to take part, please click the consent form on the next page to start the survey.

Thank you very much for your consideration.
Amnah Alshahrani.

Start of Block: Consent Form

The informed consent agreement for this study is provided below. Please review the text and click "Yes" if you agree to participate and "No" if you do not agree to participate.

I confirm that I have read and understood the information above.
I understand that my participation is voluntary and that I am free to withdraw at any time, without having to give a reason and without any consequences.
I understand that the survey is anonymous and that I cannot be identified.
I understand that once the survey is submitted my responses cannot be withdrawn.
I understand that the data captured will be used in this study and associated publications and may be made available to other researchers.
I understand that on completion the data will be stored in the university data archive repository.
I consent to taking part in the survey.

I agree to participate in this study:

- ◯ No
- ◯ Yes

Did you study computing at school?

- ◯ Yes
- ◯ No

Start of Block: computing at school.

At school I learned (select all that apply):

- ☐ How to use applications such as word processors and spreadsheets
- ☐ The basics of programming
- ☐ A significant amount of programming
- ☐ Problem solving (computational thinking)
- ☐ Other topics in computing (please specify below)

Start of Block: Rate the school experience.

My experience of computing at school was:

- ○ Excellent
- ○ Above Average
- ○ Average
- ○ Below Average
- ○ Very Poor

Start of Block: Computing at school related to Uni.

The computing that I studied at school helped prepare me to study computing at University:

- ○ Strongly Disagree
- ○ Disagree
- ○ Neutral
- ○ Agree
- ○ Strongly Agree

Start of Block: Rate the computer curricula.

The computing that I studied at school was:

- Very Easy
- Easy
- Moderate
- Difficult
- Very Difficult

Start of Block: Compulsory or optional

The computing that I studied at school was:

- Compulsory
- Optional
- Some Optional

Start of Block: class environment.

Computing at school was fun:

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

Computing at school was boring:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

My computing classes at school were:

- ◯ Majority male
- ◯ Majority female
- ◯ Mixed gender

Start of Block: Computing outside school

Did you study any computing outside of the school curriculum (select all that apply)?

- ☐ None
- ☐ Online course(s) in computing topics
- ☐ Coding club
- ☐ Self-taught
- ☐ Internship
- ☐ Worked in Computing
- ☐ Others (please specify below):

Start of Block: Rate CS experience

My overall experience of computing before university was:

- ○ Excellent
- ○ Good
- ○ Average
- ○ Poor
- ○ Terrible

Start of Block: Prior Experience

My experience of computing before university influenced me to choose to study computing at university:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Start of Block: Social support

I chose to study computing at university because I received encouragement from (select all that apply):

- ▢ A parent
- ▢ Another family member
- ▢ My computing teacher
- ▢ One of my other high school teachers
- ▢ A friend
- ▢ I have not received any encouragement

In your opinion, the family can play an important role in the decision of students to choose to study computing at university:

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

In your opinion, the school can play an important role in the decision of students to choose to study computing at university:

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

Start of Block: Self-efficacy

I chose to study computing at university because:	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I had good skills in computing before coming to university.	○	○	○	○	○
I had good skills in math before coming to university	○	○	○	○	○
I liked to design and create new things	○	○	○	○	○
I had good problem-solving skills	○	○	○	○	○
I play video games	○	○	○	○	○
I used technology in my daily life	○	○	○	○	○

Before coming to university, how confident were you in your ability to study computing at university:

○ Extremely Confident

○ Confident

○ Neutral

○ Unsure

○ Extremely Unsure

At university, how confident are you in your ability to study computing:

- ○ Extremely Confident
- ○ Confident
- ○ Neutral
- ○ Unsure
- ○ Extremely Unsure

At the moment, I would describe my feelings about studying computing at university as (select all that apply):

- ☐ Happy
- ☐ Stressed
- ☐ Challenged
- ☐ Other, (please specify below):

It is important for computing students at university to have a passion to study computing:

- ○ Strongly Disagree
- ○ Disagree
- ○ Neutral
- ○ Agree
- ○ Strongly Agree

It is important for students to have some computing skills before choosing to study computing at university:

- ○ Strongly Disagree
- ○ Disagree
- ○ Neutral
- ○ Agree
- ○ Strongly Agree

I chose to study computing at university because I was interested in computing:

- ○ Strongly Disagree
- ○ Disagree
- ○ Neutral
- ○ Agree
- ○ Strongly Agree

Start of Block: Expectation

By studying computing at university, I expect to (select all that apply):

- ☐ Get a well-paid job
- ☐ Easily get a job
- ☐ Have many job opportunities
- ☐ Gain more knowledge of computing
- ☐ Help society
- ☐ Have an opportunity for postgraduate study
- ☐ Others (please specify below):

Which one of the following **MOST** influenced your choice to study computing at university?

- ○ To get a well-paid job
- ○ To easily get a job
- ○ To have many job opportunities
- ○ To gain more knowledge of computing
- ○ To help society
- ○ To have an opportunity for postgraduate study
- ○ Other (please specify below):

Start of Block: Most influence factor

Which one of the following factors **MOST** influenced you to study computing at university?

○ My previous experience in computing

○ The encouragement I received from others

○ My interest in computing

○ My expectations of the benefits of a computing degree

○ Other (please specify below):

Start of Block: Perception 1

In your opinion, society encourages males to study computing at university:

○ Strongly Disagree

○ Disagree

○ Neutral

○ Agree

○ Strongly Agree

In your opinion, society encourages females to study computing at university:

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

Recently, society's view of whether males should study computing at university is:

- ◯ Extremely Positive
- ◯ Positive
- ◯ Neutral
- ◯ Negative
- ◯ Extremely Negative

Recently, society's view of whether females should study computing at university is:

- ◯ Extremely Positive
- ◯ Positive
- ◯ Neutral
- ◯ Negative
- ◯ Extremely Negative

Society views students who choose to study computing as (select all that apply):

- ▢ Analytical
- ▢ Nerdy
- ▢ Non-social
- ▢ Over-achiever
- ▢ Shy
- ▢ Smart
- ▢ Social
- ▢ Wealthy
- ▢ Others, please specify below:

Start of Block: Suggestions

Can you identify any factors that could help encourage male students to study computing at university?

Can you identify any factors that could encourage female students to study computing at university?

What factors discourage male students from studying computing at university?

What factors discourage female students from studying computing at university?

Start of Block: Background information

What is your gender?

- ◯ Male
- ◯ Female
- ◯ Other

What is your age?

- ◯ 17 to 20 years
- ◯ 21 to 23 years
- ◯ 24 to 26 years
- ◯ 27 to 29 years
- ◯ 30 or above

What type of school did you attend?

○ State (non-fee paying)

○ Fee-paying

○ Other (please specify below):

Where did you attend your high school?

○ Scotland

○ Other (please specify):

Prior to studying computing were you:

○ At school

○ At college

○ On a different degree course

○ Working

○ Other (please specify):

Which year are you in at university?

○ First year

○ Second year

○ Third year

○ Fourth year

○ Fifth year

Which university do you attend?

▼ University of Aberdeen (1) ... Another University (14)

When did you decide to study computing at university?

- ◯ At school
- ◯ After school
- ◯ After a university open day
- ◯ Other please specify below:

What was your favorite subject at school?

- ◯ Math
- ◯ Biology
- ◯ Chemistry
- ◯ English
- ◯ History
- ◯ Computing
- ◯ Other (please specify):

If your favorite subject at school was not computing, why did you choose to study computing rather than that subject?

To enter the prize draw, please write your email address below, or if you do not wish to enter the prize draw please leave blank. Note, to preserve anonymity, this email address is stored separately from the data recorded above and will only be used to identify the winners of the prize draw. All email addresses will be deleted after the prize draw.

Start of Block: Not studied computing at school.

No, I did not study computing at school because:

- ○ There was computing at my school, but I chose not to study it.
- ○ There was no computing subject in my school.
- ○ Other reasons (please specify below):

Start of Block: Not to Participate

Thank you for your time.
Since you do not like to participate in this study. And I hope to see you in another study.

Appendix G: Example of quantitative data analysis

Did you study any computing outside of the school curriculum (select all that apply): - Selected Choice Online course(s) in computing topics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	54	72.0	72.0	72.0
	Yes	21	28.0	28.0	100.0
	Total	75	100.0	100.0	

Did you study any computing outside of the school curriculum (select all that apply): - Selected Choice Coding club

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	61	81.3	81.3	81.3
	Yes	14	18.7	18.7	100.0
	Total	75	100.0	100.0	

Did you study any computing outside of the school curriculum (select all that apply): - Selected Choice Self taught

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	56	74.7	74.7	74.7
	Yes	19	25.3	25.3	100.0
	Total	75	100.0	100.0	

Did you study any computing outside of the school curriculum (select all that apply): - Selected Choice Internship

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	69	92.0	92.0	92.0
	Yes	6	8.0	8.0	100.0
	Total	75	100.0	100.0	

Did you study any computing outside of the school curriculum (select all that apply): - Selected Choice Worked in computing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	70	93.3	93.3	93.3
	Yes	5	6.7	6.7	100.0
	Total	75	100.0	100.0	

Did you study any computing outside of the school curriculum (select all that apply): - Selected Choice Others (please specify below):

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	69	92.0	92.0	92.0
	Yes	6	8.0	8.0	100.0
	Total	75	100.0	100.0	

My overall experience of computing before university was:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	15	20.0	20.0	20.0
	Good	28	37.3	37.3	57.3
	Average	20	26.7	26.7	84.0
	Poor	8	10.7	10.7	94.7
	Terrible	4	5.3	5.3	100.0
	Total	75	100.0	100.0	

My experience of computing before university influenced me to choose to study computing at university:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	4	5.3	5.3	5.3
	disagree	5	6.7	6.7	12.0
	Neutral	11	14.7	14.7	26.7
	Agree	25	33.3	33.3	60.0
	Strongly agree	30	40.0	40.0	100.0
	Total	75	100.0	100.0	

I chose to study computing at university because I received encouragement from (select all that apply): A parent

		Frequency	Percent	Valid Percent	Cumulative Percent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	38	50.7	50.7	50.7
	Yes	37	49.3	49.3	100.0
	Total	75	100.0	100.0	

I chose to study computing at university because I received encouragement from (select all that apply): Another family member

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	54	72.0	72.0	72.0
	Yes	21	28.0	28.0	100.0
	Total	75	100.0	100.0	

I chose to study computing at university because I received encouragement from (select all that apply): My computing teacher

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	38	50.7	50.7	50.7
	Yes	37	49.3	49.3	100.0
	Total	75	100.0	100.0	

I chose to study computing at university because I received encouragement from (select all that apply): One of my other high school teachers

		Frequency	Percent	Valid Percent	Cumulative Percent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	59	78.7	78.7	78.7
	Yes	16	21.3	21.3	100.0
	Total	75	100.0	100.0	

I chose to study

computing at university because I received encouragement from (select all that apply): A friend

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	56	74.7	74.7	74.7
	Yes	19	25.3	25.3	100.0
	Total	75	100.0	100.0	

I chose to study

computing at university because I received encouragement from (select all that apply): I have not received any encouragement

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	58	77.3	77.3	77.3
	Yes	17	22.7	22.7	100.0
	Total	75	100.0	100.0	

In your opinion, the family can play an important role in the decision of students to choose to study computing at university:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	2.7	2.7	2.7

	Disagree	1	1.3	1.3	4.0
	Neutral	8	10.7	10.7	14.7
	Agree	38	50.7	50.7	65.3
	Strongly agree	26	34.7	34.7	100.0
	Total	75	100.0	100.0	

In your opinion, the school can play an important role in the decision of students to choose to study computing at university:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	2.7	2.7	2.7
	Disagree	2	2.7	2.7	5.3
	Neutral	6	8.0	8.0	13.3
	Agree	37	49.3	49.3	62.7
	Strongly agree	28	37.3	37.3	100.0
	Total	75	100.0	100.0	

What factors

discourage female students from studying computing at university?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		22	29.3	29.3	29.3
	* There are very few women leaders in the computing industry; hence the field is often construed to be one with an unfriendly work environment for women.	1	1.3	1.3	30.7

	A society's belief that Computer Science is mostly for males.	1	1.3	1.3	32.0
	As I mentioned earlier, social inequality is a big factor that discourages female students from studying computing. Also, it is a well-known fact that companies tend to hire male computer scientists and females are less likely to become managers in this area.	1	1.3	1.3	33.3
	being female and western society having weird stereotypes around that	1	1.3	1.3	34.7
	Being one of the only females doing it	1	1.3	1.3	36.0
	Challenging course, male dominated	1	1.3	1.3	37.3
	Cyclical, but the gender imbalance itself - I remember going to university interviews/open days and being the only female there, which was definitely off putting.	1	1.3	1.3	38.7
	expectations from parents to study sth else, not enough exposure.	1	1.3	1.3	40.0
	Feeling inadequate amongst, and being intimidated by male peers. Spending time with mostly men can be uninspiring.	1	1.3	1.3	41.3

	Feeling lonely in male-dominated environments. Being worried about relationships with male peers being reduced to romantic interest, thus lowering the comfort of socialization with peers in computing.	1	1.3	1.3	42.7
	Having fellow male students talk down to you	1	1.3	1.3	44.0
	How the massive a difference the ratio of males to females in computing is portrayed. My family advised be against studying computing as it is so male dominated that they won't want to hire a woman.	1	1.3	1.3	45.3
	I think male/female ratio and the sometimes negative connotations of the subject (e.g. nerdy, etc). Also a lot of girls in my school saw it as an admin subject and didn't take it because of that.	1	1.3	1.3	46.7
	It is male-dominated It is challenging if you expect perfection Thinking that everyone already knows a lot/previous knowledge is needed	1	1.3	1.3	48.0
	Lack of other females in the course, some judgement from males also taking the course (normally unintentional)	1	1.3	1.3	49.3

	lack of other women on the course	1	1.3	1.3	50.7
	Male dominated course. As a female in the course, it’s actually really difficult to be taken seriously	1	1.3	1.3	52.0
	Mostly male environment, society's views on computer as being a male thing.	1	1.3	1.3	53.3
	n/a	1	1.3	1.3	54.7
	Not a lot of role models; both over the media and at home	1	1.3	1.3	56.0
	not common	1	1.3	1.3	57.3
	Not many females. May not have as much experience as boys (gaming, coding etc)	1	1.3	1.3	58.7
	not many girls study it, stereotypically a guys degree	1	1.3	1.3	60.0
	Peer pressure from males	1	1.3	1.3	61.3
	pre-existing ratio that's not in our favour, the stereotype that comp sci boys are gross nerds	1	1.3	1.3	62.7

	Sexism - the traditional view that the sciences are too strenuous for women who should only concern themselves with the arts until they settle down and start a family. And yet, even in the arts it is accepted that the highly successful men in the field are 'talented' and the women have to truly 'work for the success'.	1	1.3	1.3	64.0
	Social attitude towards them	1	1.3	1.3	65.3
	Social prejudices	1	1.3	1.3	66.7
	Society bias. Woman should stay in home. Computer is for guys not for girls, and family pressures, a lot of parents still didn't see how powerful this subject is going to be in the future	1	1.3	1.3	68.0
	Some feel it's male dominated	1	1.3	1.3	69.3
	Some may think they have to be particularly good at maths to succeed or they need to have prior experience in programming before starting their degree.	1	1.3	1.3	70.7

	Stereotype of computer science students, not knowing exactly what computer science involves, male dominated degree, discrimination against women in tech, think it is too difficult, never had any experience in programming before	1	1.3	1.3	72.0
	Stereotypes of computing students	1	1.3	1.3	73.3
	That there is an imbalance between the number of females and males.	1	1.3	1.3	74.7
	That they don't believe they could do it	1	1.3	1.3	76.0
	The fact that the majority of students, staff and future colleagues will be male, with that comes discrimination, disrespect, mansplaining, being treated as stupid. Not in all cases, of course, but enough to make your life a lot harder.	1	1.3	1.3	77.3
	The fact that they give up too easily when they discover guys with a family support for mechanics and related problems are better at it at the beginning	1	1.3	1.3	78.7
	The fear for math. lack of encouragement from society.	1	1.3	1.3	80.0

	The gender gap in classes in school and it isn't encouraged as much as other career path	1	1.3	1.3	81.3
	The idea that a lot of people in the course will be males and will generally know a lot about computers. This could also apply to males but I know myself coming into university I felt like I wasn't good enough o be in the course due to a lot of people being gamers and knowing how to program since they were young which I never learned until high school because it was generally viewed as a stereotypical male skill before females were pushed to learn it	1	1.3	1.3	82.7
	The lack of females The constant response of 'oh that's hard'	1	1.3	1.3	84.0
	The majority of male students, the stereotype and from what society thinks of you as female computer science student, you as sometimes looked down upon.	1	1.3	1.3	85.3

	The social stigma - at the moment people would assume female students studying computer science to be nerdy. The lack of females in the profession - some may be put off if they think they will be the only girl in the class. Some girls may be under confident and not believe they have the skills to study this subject.	1	1.3	1.3	86.7
	The stereotype and the lack of encouragement. Also that there is so few women it can be quite daunting	1	1.3	1.3	88.0
	The stereotype of a computing student and the fact that the subject is more male dominated	1	1.3	1.3	89.3
	the studies and jobs related to it are heard to be of a lot pressure	1	1.3	1.3	90.7
	Their female relatives, ignorance/inexperience	1	1.3	1.3	92.0
	there are too many men, they don’t feel clever enough	1	1.3	1.3	93.3
	There is a big gender imbalance which can make you feel out of place and make it harder to fit in. Plus there are lots of stereotypes about men and women's roles especially in STEM, including in CS.	1	1.3	1.3	94.7
	They don't like the subject	1	1.3	1.3	96.0

	They have no interest in computing, or they are discouraged by negative environments.	1	1.3	1.3	97.3
	They may think this makes them look bad or maybe be embarrassed that there's so many males compared to females and this may put them off.	1	1.3	1.3	98.7
	Too many males; stereotypes of computing being a 'boys' subject and false expectations of women pursuing more 'feminine' degrees.	1	1.3	1.3	100.0
	Total	75	100.0	100.0	