Designing for STEM E-Mentoring for Young Women: the Saudi Context

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Abstract

The underrepresentation of women in the STEM workforce is a global issue. In Saudi Arabia, women constitute 48% of undergraduates in STEM. This is in large part a result of the unique cultural context, gender segregation in educational institutions and the perceived prestige associated with studying a STEM subject for both women and men. However, these high levels of educational participation have not translated into a significant increase in the number of women in the STEM workforce. The exposing of girls to female role models and mentors in STEM, and raising awareness of their achievements and successes, is an approach that has been developed by previous research to address perceptions that girls are less likely to succeed in a STEM field than boys. In Saudi Arabia, the lack of female role models and the absence of mentoring and support programmes are likely some of the factors that have contributed to the low levels of progression of female graduates into STEM professions.

In this research, I explore the current state of e-mentoring, seek to understand the requirements in designing STEM e-mentoring platforms for teenagers and young women in the Saudi context and understand how mentors and mentees interact within an e-mentoring relationship. I conducted four studies that aimed to understand, design and evaluate e-mentoring in the Saudi context. First, I deployed a structured STEM e-mentoring program, with the aims of understanding the applicability of e-mentoring in Saudi Arabia. The findings from this study led to carrying out two co-design studies to explore the perceived barriers to, and opportunities for, alternative and more flexible forms of e-mentoring. The findings from the three studies have led to the design of *Qudwa* based on four design requirements: 1) flexibility and control; 2) visibility; 3) integration of e-mentoring with daily internet activity; and 4) a trusted connection between mentors and mentees. Finally, I discuss the deployment and evaluation of *Qudwa*.

This research makes three contributions, first it is the first systematic investigation of e-mentoring in Saudi Arabia. While I aimed to understand the role of cultural norms, the studies show that the findings are affected less by cultural norms and more by the traits of the participants' age group. The second novel contribution of this research is the application of co-design methods to help address the gap in understanding the needs and opportunities in designing e-mentoring for young people. The results point to a need for a shift in the design of e-mentoring models for younger generations into less committed and more flexible relationships. Finally, it presents the design and evaluation of *Qudwa*, which facilitates e-mentoring through existing social media technologies and practices (un-platforming).

To my kids Layan, Dana and Abdulaziz

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Chapter 1 Introduction

1.1 Overview

This research aimed to study science, technology, engineering and mathematics (STEM) e-mentoring in Saudi Arabia from a human–computer interaction (HCI) perspective. The aims of the STEM e-mentoring were to expose young Saudi women and teenagers to female role models and mentors in STEM, and raise their awareness about achievements, successes and career opportunities. Saudi Arabia has a unique cultural norm that is different from other contexts. While e-mentoring is applied widely in the Western context, it is not in Saudi Arabia or similar contexts. Therefore, this research aimed to apply exploratory research to understand and study how e-mentoring can be applied in this context appropriately within the culture and how participants would interact within an e-mentoring relationship. Exploratory research tends to have a qualitative nature (Hanington, 2010; Stebbins, 2001). In this research, qualitative methods were applied to gain a full understanding of e-mentoring in the area of the study. In HCI, qualitative methods are essential methods for understanding the area and users, gathering requirements and evaluating outcomes (Adams et al., 2008; Blandford et al., 2016). In this research, several qualitative methods were used to elicit data and requirements including interviews, pre-study and post-study surveys, focus groups, co-design workshops and observation of interactions.

Four studies were conducted to fulfil this aim. The first step was to apply a STEM e-mentoring program for Saudi female teenagers to explore its potential in the context. The initial exploration reported that the cultural norms had little effect on the requirements and needs, and suggested that age group traits are what dictate the design requirements. Therefore, two co-design studies were conducted with the targeted population to gain a deeper understanding of the design requirements and needs. Based on these requirements, *Qudwa* was designed. *Qudwa* is based on the idea of un-platforming, which facilitates existing social media networks to develop less committed and more flexible e-mentoring relationships.

1.2 Motivation

It has been widely observed that the participation rate of girls in the STEM fields is lower than that of boys. In some countries, such as the USA, the proportion of women in the STEM workforce is significantly lower (i.e., less than 25%) than that of men, despite sustained national, regional and local policy initiatives (Beede et al., 2011; Khare et al., 2013). On the other hand, participation in STEM subjects in further and higher education in a number of

countries in the Middle East and North Africa region has approached gender equity, as over the past five decades there has been a significant and steady growth in the proportion of women and girls studying STEM subjects at school and in university (Ramirez and Kwak, 2015). For example, in Saudi Arabia 48% of undergraduates in STEM subjects are female (Ministry of Education, n.d.). This high rate is in large part a result of the unique cultural context, gender segregation in educational institutions and the perceived prestige associated with studying a STEM subject for both women and men. However, these high levels of educational participation have not translated into a significant increase in the number of women in the STEM workforce. The statistics of Saudis employed in 2015 showed that the number of newly employed Saudi women in STEM sectors was lower in comparison to other sectors. For example, only 3% of Saudis who were employed in the energy sectors were female and in the science and technology sector 17% were female, while Saudi women represented 55.7% of newly employed Saudis in the social services sector and 74.6% in the education sector (General Authority for Statistics, 2015). In 2016, women in Saudi Arabia accounted for 33% of the workforce, 39.5% of them in clerical jobs, 3.3% in the engineering workforce, 1.4% in the industrial and chemical sectors, and 4% in the information and communication technology (ICT) workforce (General Authority for Statistics, 2016).

In addition, Saudi women and girls continue to be discouraged by prevailing social attitudes and a climate of cultural self-restriction (Abalkhail and Allan, 2015; Al-Asfour et al., 2017). These factors are likely to have contributed to the low levels of progression for female STEM graduates into STEM professions (Abalkhail and Allan, 2015; Al-Asfour et al., 2017). The lack of female role models and the absence of mentoring and networking programs were identified as some of the main barriers for the professional advancement of women in Saudi Arabia in different fields such as medicine (Alwazzan and Rees, 2016), leadership in higher education (Alsubaie and Jones, 2017) and entrepreneurship (Danish and Smith, 2012). Fundamental issues arise around Saudi women in STEM. The lack of female role models and the lack of mentoring and networking support systems have been some of the reasons for the low participation of women in STEM jobs even though almost half of the Saudi undergraduates in STEM fields are female.

1.2.1 *Global initiatives to advocate STEM for women*

Recently, there have been many regional and global initiatives to encourage girls into STEM studies and careers; for example, initiatives instigated by the IEEE Women in Computing

Society[1], Arab Women in Computing[2] and Society of Women Engineers[3]. Moreover, a number of awards have been established to recognise women in STEM, including the Women in IT Awards[4], and L'Oréal-UNESCO Women in Science Awards[5]. Outreach-targeted promotional programs have also been developed to promote girls' interest in STEM careers and shed light on the value of STEM professions. For example, NASA has developed SISTER, a one-week summer outreach program that aims to inspire young girls by exploring non-traditional career fields with women engineers, mathematicians and scientists (Garner, 2016). Many attempts have been made to address the misconception that girls are less likely to succeed in STEM fields than boys by exposing girls to female role models in STEM and raising awareness of their achievements, successes and everyday professional activities. These so-called *mentors* perform a considerably larger role than acting as simple role models: they encourage, advise, counsel and share their knowledge with the girls involved (Stoeger et al., 2013). Ensher et al. (2003) described a mentor's responsibility towards their mentees as falling into three categories: vocational support, psychological support and role modelling. Organisations such as Million Women Mentors[6] promote traditional face-to-face mentoring for women and young girls to increase their interest in STEM and help them achieve their goals. However, the organisation of such face-to-face mentoring programs faces a number of significant challenges, including the availability of mentors, mentor training and geographical distance. These barriers can be reduced through the use of computer-mediated communications in e-mentoring (Bierema and Merriam, 2002; Khare et al., 2013). Accessibility, efficiency, flexibility and personalisation have all been identified as advantages of e-mentoring over traditional face-to-face mentoring (Khare et al., 2013).

My personal experience of being a Saudi woman in a STEM field has driven this research. During my undergraduate studies, I faced frustration and confusion in understanding different fields and career options. I needed someone to guide and support me, a female who had been in the same circumstances. I could not reach out to any professional Saudi women at that time and age. I studied computer science not because I have knowledge about it or was interested in it, but because my school grades were excellent. The cultural norm (for males and females) was to study medicine, computer science or engineering if you had high grades.

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[1] https://www.computer.org/communities/women-in-computing

[2] http://arabwic.org/

[3] http://societyofwomenengineers.swe.org/

[4] http://womeninitawards.com/

[5] https://www.forwomeninscience.com/en/awards

[6] https://www.millionwomenmentors.com

Engineering colleges were not available for females at that time and medicine was not appealing to me, so I choose to study computer science. After graduation, my knowledge about career options was also limited. It was common for Saudi women to work in either the health sector or the education sector. I applied for a job as a teaching assistant at the university and still work there. I have two daughters, who will be applying for university in a couple of years, thinking about different fields and career options, and I wish for them a better experience and wider options than mine.

The specific objective of this research was to examine e-mentoring in the Saudi context. This examination has been conducted through four studies that applied e-mentoring, explored the needs and requirements, then designed, deployed and evaluated a new STEM e-mentoring system to encourage teenagers and young women in Saudi Arabia to pursue STEM academic degrees, advise them and raise their awareness about STEM career opportunities.

1.3 Research Context

1.3.1 *E-mentoring*

Definitions and functions

A mentor is defined by Zey (1984, p. 7) as a person "who oversees the career and development of another person, usually a junior, through teaching, counselling, providing psychological support, protecting, and at times promoting or sponsoring." Given the long history of mentoring, there is a lack of a unified definition and specified functions of mentoring (Crisp and Cruz, 2009; Haggard et al., 2011; Jacobi, 1991). Jacobi (1991) presented 15 different definitions of 'mentoring' and 'mentor' from the literature in the fields of education, management and psychology. Haggard et al., (2011) found over 40 definitions of a mentor. Crisp and Cruz (2009), through their review of the literature, identified over 50 definitions of mentoring depending on the field or the discipline. For example, Crisp and Cruz (2009) reported that Roberts (2000) defined mentoring as "a formalized process whereby a more knowledgeable and experienced person actuates a supportive role of overseeing and encouraging reflection and learning within a less experienced and knowledgeable person, so as to facilitate that person's career and personal development", while Blackwell (1989) said that mentoring "is a process by which persons of a superior rank, special achievements, and prestige instruct, counsel, guide and facilitate the intellectual and/or career development of persons identified as protégés."

In comparison to the wide range of English definitions of 'mentoring' and 'mentor', the Arabic language lacks words for mentoring, mentor and mentee. Since "language

expresses cultural reality", as noted by Kramsch and Widdowson (1998), the lack of the word 'mentoring' in the Arabic language emphasises the fact that mentoring is not a recognised concept in Saudi Arabia and the Arab region.

Despite the fact that there is inconsistency in the definitions of mentoring, Jacobi (1991) presented the aspects on which researchers have agreed about mentoring. First, while the forms of the mentoring relationship may vary, they all serve the purpose of helping and assisting the mentee. Second, the mentoring relationship helps in providing emotional and psychological support, career and professional development, and role modelling. Third, the benefits of mentoring are mutual for both the mentor and mentee. Fourth, mentoring relationships are personal and require direct contact between a mentor and a mentee. Finally, mentors have more expertise, power and accomplishment in comparison to their mentees.

The advancement of technology and computer-mediated communications (CMC) have provided enhancement and development of the mentoring process (Bierema and Merriam, 2002). E-mentoring is based on the application of technology for communication between mentors and mentees. It has been found that the earliest form of e-mentoring was developed in 1994 (Mason et al., 1994). The aim of the project was to mentor school students by university students to improve their writing skills via "telecommunications technology", which was not described. Interestingly the authors explained that they would use the term 'mentor' instead of 'tutor' as the term 'tutor' was commonly used at that time. It seems that back in the early 1990s mentoring was concerned with emotional and psychological support, and started expanding to career development and skill enhancement; as the authors said, "we believe that a mentor not only provides emotional and psychological support but also provides direction in career and professional development" (Mason et al., 1994, p. 124).

Other terms have been used to describe the use of CMC in mentoring such as telementoring, cybermentoring, virtual mentoring and online mentoring (Rowland, 2012; Single and Muller, 2001). The term 'e-mentoring' is better because it indicates the use of electronic communication such as email (Single and Single, 2005). E-mentoring has been defined as "a computer mediated, mutually beneficial relationship between a mentor and a protégé which provides learning, advising, encouraging, promoting, and modeling, that is often boundaryless, egalitarian, and qualitatively different than traditional face-to-face mentoring" (Bierema and Merriam, 2002, p. 214).

The terms 'mentee' and 'protégé' have been used in the literature to describe the person who is being mentored. Some works have used both terms interchangeably; for example, Crisp and Cruz (2009) in their review of the literature used both terms without

distinguishing them. Other examples of using both terms are found as well (Dawson, 2014; DiRenzo et al., 2013; Risquez, 2008; Rowland, 2012).

In the dictionaries, a mentee is defined as:

> a person who is advised and helped by a more experienced person over a period of time (Oxford Learner's Dictionaries, n.d.)

> a person who is helped by a mentor (Cambridge Dictionary, n.d.)

Protégé has a French origin that means 'protected' (Oxford Learner's Dictionaries, n.d.). It has been defined as:

> a young person who is helped in their career and personal development by a more experienced person (Oxford Learner's Dictionaries, n.d.)

> a young person who is helped and taught by an older and usually famous person (Cambridge Dictionary, n.d.)

Klasen and Clutterbuck (2012) favoured the term 'mentee' over 'protégé'. They explained that 'protégé' means "protected one", which indicates inequality of power in the mentoring relationship, while power should be excluded from the mentoring relationship. This also implies that the 'protégé' is naïve and has nothing to add to the relationship, which is not true; even though the mentee is the one seeking help or knowledge, the mentor learns and benefits from the mentee as well (Klasen and Clutterbuck, 2012). The term 'mentee' will be used in this work to describe the person who is being mentored.

It has been found that e-mentoring provides the same benefits and support to the mentees that are provided in other forms of mentoring (Single and Single, 2005). Bierema and Merriam (2002) proposed that a mentor's role or function is to provide the mentee with help and assistance needed in any aspect that ensures their development and to be a role model for them to learn from and observe. Risquez (2008) mentioned that a mentor facilitates the professional or personal development of a mentee during a transitional time in their lives. Ensher et al. (2003) defined three functions of a mentor: vocational or instrumental support, psychological support and role modelling. Vocational or instrumental support is related to the professional development of the mentee, psychological support is related more to counselling, encouragement and building self-esteem, and role modelling is related to presenting an example for the mentee to follow and be influenced by. Single and Single (2005) stated three roles for a mentor, two of them matching those of Ensher et al. (2003): psychosocial support and instrumental support. The third role presented by Single and Single (2005) is informational support, which means the process of sharing information and knowledge requested by the mentee on a particular matter or subject.

While e-mentoring is described as a "mutual beneficial relationship" (Bierema and Merriam, 2002), the benefits for mentors and mentees differ, and most studies have focused on mentees' benefits in a mentoring relationship (Ehrich et al., 2004). A review of the literature shows that networking, reflection, professional development and personal satisfaction are among the most cited benefits for the mentors (Ehrich et al., 2004).

Advantages of e-mentoring

Space and time limitations were the two most commonly faced obstacles to maintaining the traditional face-to-face mentoring relationship; these obstacles are overcome by e-mentoring (Bierema and Merriam, 2002; Rhodes et al., 2006; Risquez, 2008; Single and Muller, 2001). Using CMC is time efficient. With online communications, travelling to and from the physical mentoring location is not required, therefore it saves travel time (Ensher et al., 2003; Single and Single, 2005). Since e-mentoring has lower time investment, it provides opportunities for mentors and mentees who find the required time for traditional mentoring an obstacle to their participation in a mentoring relationship (Single and Muller, 2001). If asynchronous means of communications are used in e-mentoring, this allows participants to engage at their convenience and reduces the pressure to respond immediately (Bierema and Merriam, 2002; Ensher et al., 2003; Single and Muller, 2001). In addition, online communication facilitates the exchange of more knowledge and information in a shorter period of time (Bierema and Merriam, 2002).

The elimination of the geographical constraints in e-mentoring gives it another benefit over traditional mentoring. Because e-mentoring is not restricted by geography, mentees are not limited to the mentors around them, which provides them with greater access (Ensher et al., 2003). With the reduction of time and space constraints, the pool of mentors available increases in e-mentoring (Ensher et al., 2003; Rhodes et al., 2006). The connection between mentors and mentees across different locations and organisations has two advantages: it expands their professional networks and it promotes impartiality (Single and Single, 2005). In traditional mentoring, the dyads in the mentoring relationship are usually from the same organisation or network. Being from the same organisation makes the mentee susceptible to judgement and may affect their professional development due to the mentor's opinion of them, or the mentee can be judged for participating in a helping program (Single and Single, 2005). On the other hand, e-mentoring provides inter-organisational connections which expand professional networks, especially for those who find it hard to have an informal mentoring relationship in their own organisation (Single and Single, 2005). In addition, e-

mentoring supports impartiality because the mentor, who is from a different organisation, has no hidden motivation for being in this relationship (Risquez, 2008; Single and Single, 2005).

The nature of online communication methods also has advantages that support e-mentoring. One main advantage is that e-mentoring conceals physical characteristics and social cues (Bierema and Merriam, 2002; Ensher et al., 2003; Single and Muller, 2001). People usually build an initial impression of another person based on their physical appearance, but with online communication in e-mentoring, participating individuals have the opportunity to focus less on outer characteristics and more on personalities, thoughts and needs (Ensher et al., 2003; Rhodes et al., 2006). Women and minority groups have fewer chances of engaging in a mentoring relationship (Bierema and Merriam, 2002). The reduced focus on demographics creates an opportunity for women, minorities and others who are excluded from traditional mentoring relationships (Bierema and Merriam, 2002; Ensher et al., 2003; Single and Muller, 2001; Single and Single, 2005). It also provides opportunities for personalities who are shy or have reservations about reaching out for mentoring from their community (Rhodes et al., 2006). In traditional mentoring, the person with higher status (the mentor) has the power and control in the relationship; on the other hand, the levelling of status in e-mentoring offers a safe context for the relationship and eliminates the power dynamics (Bierema and Merriam, 2002; Ensher et al., 2003; Single and Single, 2005). Equalisation of status provides a comfortable environment for mentees who perceive themselves as lower than their mentor (Ensher et al., 2003; Single and Single, 2005). Honesty and self-disclosure also tend to be of higher levels in e-mentoring due to the nature of the online communication methods (Rhodes et al., 2006).

The use of CMC liberates e-mentoring from time and geographical constraints, which results in saved time and cost, and expands professional networks. However, e-mentoring is not cost-free, due to the need for websites, administration, matching protocols and evaluation techniques (Single and Single, 2005). While CMCs have the advantage of concealing social cues and status, which creates a safe environment and opportunities for more diverse mentees to be in an e-mentoring relationship, it may create an easier context for mentees to ignore or terminate the e-mentoring relationship (Single and Single, 2005) or an environment where harmful messages can be easily exchanged (Rhodes et al., 2006). Miscommunication or misinterpretation can be a challenge faced in CMC as well (Ensher et al., 2003; Rhodes et al., 2006).

1.3.2 *The Saudi context*

ICT in Saudi Arabia

In the late 1990s the internet was launched to the public in Saudi Arabia (Alshahrani, 2016). The delay compared to other countries came from the conservative nature of Saudi society. The government had concerns and reservations about introducing internet service to the society (Alshahrani, 2016). In 1997, an official decree was issued to give the King Abdulaziz City for Science and Technology (KACST), which is an organisation that reports to the Prime Minister of Saudi Arabia, the responsibility to provide and control the internet in Saudi Arabia (Alshahrani, 2016). KACST filters and supervises the internet gateways and blocks undesired websites to ensure that the content delivered is culturally acceptable. Despite the delay in the launching of the internet, Saudi Arabia is considered the fastest and largest growing Arab country in terms of the use of ICT and internet user population (Alshahrani, 2016; Bafakih et al., 2016; Stanger et al., 2017). According to Stanger et al. (2017), Saudi Arabia has been among the top ten highest performing countries on the International Telecommunication Union's ICT development index since 2010. Statistics show that Saudi Arabia ranked second (after Iran) in the number of internet users in the Middle East, with 18 million users (Bafakih et al., 2016). The number of internet users jumped from one million users in 2003 to 16.5 million users in 2013, which represents more than half (55.1%) of the Saudi population (Alshahrani, 2016).

Saudis are avid consumers of global media and widening access to the internet in Saudi Arabia (Bafakih et al., 2016; Winder, 2014) has led to rapid and intense adoption of social media by young Saudis in particular (Bafakih et al., 2016). Globally, Saudi Arabia has ranked number one in the highest annual growth rate of social media users and as the country with the highest level of Snapchat adoption (Radcliffe and Bruni, 2019). In 2017, the Arab Social Media Report showed that Saudi Arabia ranked number one in the number of Twitter users and the number of shared tweets in the Arab region (Salem, 2015). In 2013, Saudi Arabia was the country with the highest Twitter usage (Winder, 2014). With increasing interest in Twitter in 2013, Facebook lost its popularity and dramatically dropped in usage from 61.17% in 2012 to 35.68% in 2013 (Reyaee and Ahmed, 2015). The highest number of views of YouTube in the world was of Saudis, with 90 million videos per day (Winder, 2014).

Despite the interest in and rapid growth of the internet and social media penetration in Saudi Arabia, there is little research on understanding the reasons which facilitated this adoption in Saudi Arabia (Akram and Albalawi, 2016) and the Arab Gulf region (Reyaee and Ahmed, 2015). It is considered that the high level of social media use by young Saudis is due

to the space that these platforms have created for them to connect with the world around them and to express their opinions to the public without being monitored (Akram and Albalawi, 2016; Winder, 2014). The high usage of social media among Saudi youth has made them more involved and engaged with their society (Kuppuswamy and Rekha, 2015). Winder (2014) in his exploration of the reasons behind the adoption of Twitter among young Saudis concluded that young Saudis use Twitter as a medium for expressing their anger in relation to financial and social issues. Young Saudi females had their share in expressing their frustration on Twitter about the ban on women drivers. In Saudi Arabia interaction between males and females is very limited, and Twitter created a space for different Saudi users to interconnect with each other, especially males and females (Winder, 2014). The adoption of social media was tested among young Saudis and the results showed that their social media adoption was motivated by the perceived connectedness and enjoyment (Akram and Albalawi, 2016) and perceived social capital (Al-Ghaith, 2015).

Saudi females, culture and ICT

Religion and culture are two key factors that determine the norms of Saudi society (Al Lily, 2011; Al-Saggaf, 2011). It has been discussed in the previous section that Saudis are high consumers of the internet, but this does not change the fact that Saudi society is still highly influenced by religion and culture (Al-Saggaf, 2016). The main aspects that characterise Saudi Arabia as a conservative country are family honour and gender segregation (Al Alhareth, 2013; Al Lily, 2011; Al-Saggaf, 2011; Al-Saggaf, 2016; Guta and Karolak, 2015; Yamin and Aljehani, 2016); these factors have also affected Saudi women's participation in the online context.

The collectivist nature of Saudi Arabia has encouraged the family honour concept, where a female does not only represent herself but also represents her whole family and, in some cases, her extended family as well (Al Lily, 2011; Al-Saggaf, 2016; Guta and Karolak, 2015). This cultural norm has made Saudi women cautious regarding revealing their private information online. The loss of private information such as name, workplace, school, address, phone number and personal photos can create serious harm to a woman herself, her family and their reputation (Al-Saggaf, 2011; Al-Saggaf, 2016; Binsahl and Chang, 2012; Guta and Karolak, 2015). Studies of the attitudes of Saudi women using social networking sites (SNS) (Al-Saggaf, 2011; Al-Saggaf, 2016; Binsahl and Chang, 2012) showed that Saudi women do not share or post their personal photos even with privacy settings set to the highest level on these sites. Even though they might have only real-life friends on their SNS, they fear that their friends might show their personal photos to others (Binsahl and Chang, 2012). Sharing

personal photos online might put them into a blackmail situation and dishonour of their family reputation (Al-Saggaf, 2011; Al-Saggaf, 2016). The fear and caution about losing private information has raised Saudi women's awareness about privacy and security in online contexts (Al-Saggaf, 2016; Binsahl and Chang, 2012; Guta and Karolak, 2015). Studies have shown that they develop a sense of self-censorship (Guta and Karolak, 2015) and awareness about privacy features and how to protect themselves in an online context (Al-Saggaf, 2011).

Saudi society tends to protect females in all aspects, hence it is not customary for a Saudi woman to leave her family for education or work (Al Alhareth, 2013; Yamin and Aljehani, 2016). When it comes to marriage or education, families favour marriage over education for their daughters, which may result in them dropping out of school or not continuing their undergraduate studies, especially in rural areas of Saudi Arabia (Al Alhareth, 2013; Yamin and Aljehani, 2016). It is believed that marriage protects family honour (Al Alhareth, 2013). Limited mobility and early marriage create obstacles to study and work for Saudi females who are located in rural areas. The freedom of movement which is provided by the internet has created an environment where these women can work and study from their homes (Al Lily, 2011).

Another factor that distinguishes Saudi society from others is the segregation between men and women, publicly and privately (Al Alhareth, 2013; Al Lily, 2011). Social interaction between men and women is inappropriate, with the exception of professional interactions (Al-Saggaf, 2016). In the real world, friendship between males and females is not culturally accepted, and the same applies in online spaces (Al-Saggaf, 2016; Guta and Karolak, 2015). Although male–female online interactions are not acceptable, the use of online identities and concealing of private information have created a space for this kind of interaction and networking to occur and to cross the gender lines created by the culture (Al Lily, 2011; Guta and Karolak, 2015). In other words, the two genders are physically separated and virtually connected (Al Lily, 2011).

Gender segregation has weakened Saudi women's voices (Al Lily, 2011; Guta and Karolak, 2015). The culture requires women to be modest, shy and reserved, so women do not share their voices or opinions in public, especially on politics and social issues (Al-Saggaf, 2011). The online space has constructed a place for Saudi women to share their opinions and views in all aspects (Al Lily, 2011; Al-Saggaf, 2011; Guta and Karolak, 2015). In fact, Saudi women's online participation is of an equal share to their counterparts (Al Lily, 2011). Saudi women use SNS to express themselves and their political and social views (Al-Jabri et al., 2015; Al-Saggaf, 2011) and as a medium to influence and create change in society (Guta and Karolak, 2015).

These cultural factors have contributed to decreases in visibility and connectedness of Saudi female professionals in society, while the development of the internet and social media networks has created a medium for gradually increasing their visibility and voice.

1.4 Research Questions

This research aimed to explore the opportunities for STEM e-mentoring in Saudi Arabia to encourage teenagers and young women into STEM fields and raise their awareness about their career opportunities and about existing Saudi female STEM professionals, which would lead to a higher level of Saudi women's participation in the STEM workforce. The research questions of the research are the following:

RQ1. What is the potential of applying a STEM e-mentoring program for teenagers and young women in the Saudi context?

RQ2. What are the factors that contribute to designing a STEM e-mentoring system for teenagers and young women in the Saudi context?

RQ3. How to design a STEM e-mentoring system for teenagers and young women in the Saudi context?

1.5 Summary of Contributions

This research contributes to this growing area of e-mentoring research in three aspects:

1. This is the first study to systematically investigate e-mentoring in Saudi Arabia. The lack of previous examples applied in the same context pointed to the need to understand the cultural norms that would affect the application of e-mentoring in Saudi Arabia. This research proves the applicability and success of e-mentoring in Saudi Arabia for teenagers and young women, and suggests the application of e-mentoring in other fields and settings in Saudi Arabia and the Arab region.

2. This research presents new insights into how co-design methods are beneficial in designing e-mentoring for young people. A novel contribution of this research is the application of co-design methods to address the gap in understanding the needs and opportunities in designing e-mentoring for young people. The application of co-design methods has contributed to a new form of e-mentoring based on the needs and requirements of the targeted mentees. Other forms of e-mentoring could emerge from applying co-design methods with different purposes and different populations.

3. This research describes the design, deployment and evaluation of *Qudwa*. *Qudwa* is an e-mentoring design that is based on utilising existing technologies to accomplish less committed and more flexible e-mentoring relationships between mentors and mentees.

This contribution shows the potential that existing technologies and social media platform have to facilitate a new form of e-mentoring.

1.6   Thesis Structure

The research presented in this thesis is structured as follows, with a brief overview of each chapter.

Chapter 2 introduces e-mentoring models and frameworks, the different e-mentoring contexts and relationships, and the means of communications that have been used, followed by examples of e-mentoring programs that were applied to advocate for STEM for females. It also gives an overview of the Saudi context, addressing the existing literature around mentoring in Saudi Arabia, the cultural factors that identify such a context and the ICT adoption by Saudis. The final section discusses co-design methods with the targeted population. The chapter concludes with the research gaps identified: the gap in the literature about Saudi Arabia regarding the non-existence of e-mentoring programs and the lack of applying co-design methods for designing e-mentoring programs.

Chapter 3 presents the methodology of this research and describes the design methods in each study.

Chapter 4 presents the first study of this research (Study 1). This pilot study was a systematic investigation of e-mentoring in Saudi Arabia. An e-mentoring program was deployed aiming to encourage high school girls in Saudi Arabia to pursue STEM higher education studies and raise their awareness of STEM career opportunities. The design, analysis and findings of the study are documented.

Chapter 5 presents the second and third studies, which are both co-design workshops. Study 2 consisted of three co-design workshops over a period of three weeks with first-year female undergraduates to understand the participants' expectations of e-mentoring. Study 3 was a one-session workshop with schoolgirls (aged 17–18). The chapter discusses the findings of both studies (Studies 2 and 3).

Chapter 6 introduces the design requirements and system design of *Qudwa*, an un-platformed STEM e-mentoring system designed to facilitate communication between Saudi female professional mentors and young female mentees. The design requirements are derived from the previously conducted studies (Studies 1, 2 and 3).

Chapter 7 presents the fourth and final study of this research. The deployment of *Qudwa,* data collection, evaluation and discussion are presented in this chapter.

Chapter 8 discusses the findings of the work presented in this thesis and highlights potential future research.

Chapter 2 Literature Review

2.1 Introduction

The literature review in this chapter addresses the concept and applications of e-mentoring in general and in Saudi Arabia specifically. The chapter begins with a description of existing e-mentoring models and frameworks, the different e-mentoring contexts and relationships, and means of communications that have been used, followed by examples of e-mentoring programs that were applied to advocate STEM for females. The following section addresses the existing literature on mentoring in Saudi Arabia. The final section discusses co-design methods with young people. It concludes with discussion of the research gaps identified from the review of the literature.

2.2 E-mentoring Models and Frameworks

Review of the literature identified a few scholarly articles that presented e-mentoring models. Single and Muller (2001) presented the model of structured e-mentoring. First, they defined structured e-mentoring as follows (Single and Muller, 2001, p. 108):

> E-mentoring that occurs within a formalized program environment, which provides training and coaching to increase the likelihood of engagement in the e-mentoring process, and relies on program evaluation to identify improvements for future programs and to determine the impact on the participants.

Their model consists of three phases: 1) planning; 2) structured implementation; and 3) assessment (Figure 2-1). In the planning phase, a holistic idea of the e-mentoring program is developed, from identifying the participating population and matching process to setting program goals. Recruitment informs mentors and mentees about the e-mentoring opportunity. Through the e-mentoring website, mentors and mentees can fill in the required applications. It is important to manage the expectations that mentors and mentees agree on, the frequency and method of contact, and the expected outcomes from their relationship. Single and Muller described three ways to match e-mentoring pairs. The first is *participant choice*, which entitles mentees to choose their own mentors based on their displayed biographies. The second is *uni-directional*, where the program administrator matches a mentee with a mentor based on the preferences of that mentee. The final matching method is called *bi-directional*, which collects the preferences of mentors and mentees to create pairs based on their preferences.
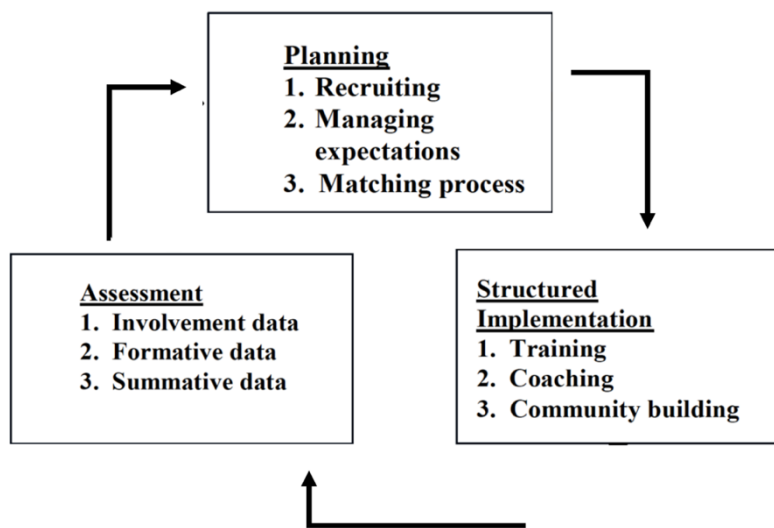
Figure 2-1 Structured e-mentoring by Single and Muller (2001)

The second phase is structured implementation, which is affected by program goals and is intended to aid the participants to make the most of their participation. It includes training, coaching and community building. At the beginning of the program, training is delivered to mentors. Training can be delivered electronically, focusing on relevant issues around mentoring and the targeted population. Coaching, on the other hand, is delivered during the program. Coaching is delivered through short messages sent to the mentor containing discussion topics and mentoring tips. Coaching helps to support the continuity of the relationship because it prompts topics for conversation. It also helps in creating a line of connection between the program administrator and the participants. Successful e-mentoring relationships occur when the program promotes a sense of community to its participants. To promote community building, the program creates a space where mentors and mentees can communicate with participants other than their one-to-one pair.

The final phase focuses on evaluation of the program. Single and Muller's (2001) assessment involves collecting three types of data for evaluation: involvement data; formative data; and summative data. According to Single and Muller (2001), the frequency of exchange is an indicator of success in e-mentoring programs. Involvement data investigates the interaction between mentors and mentees by examining their relationship, frequency and engagement. Formative data relates to the process of mentoring and help with the modification and improvement of the program – it is the data that helps to improve future iterations of the program. The final type of data is summative data, which addresses the effectiveness and outcomes of the program by evaluating the achievement of the program's goals and the value.

Bierema and Merriam (2002, p. 214) in their work provided a definition of e-mentoring:

> e-mentoring is a computer mediated, mutually beneficial relationship between a mentor and a protégé which provides learning, advising, encouraging, promoting, and modeling, that is often boundaryless, egalitarian, and qualitatively different than traditional face-to-face mentoring.

They proposed a conceptual framework in order for e-mentoring relationships to be successful. The first step is to have the right tool (i.e. a proper computer with internet access) and to have knowledge of how to use it. The second step is to identify and match the mentors and the mentees. After that, the relationships are formed by managing the expectations of both parties and the frequency of exchanges. They emphasised that regular communication between mentors and mentees is a key factor in the success of e-mentoring. The expected regularity of contact is set to twice a week in order to form a relationship. The next step is to foster familiarity between them by sharing personal experiences, lives and interests, providing support and facilitation to monitor, support and make sure that communications are going on between mentors and mentees. The final step is to provide a positive end or closure to the relationship.

O'Neill (2004) in his work used e-mentoring as a facilitator in a knowledge-building community. He presented the "mentoring in the open" model, which is different from previous models in the sense that mentees are grouped together with a mentor. Therefore, there is no private one-to-one communication between mentors and mentees. O'Neill (2004) reported that this "mentoring in the open" model had three advantages: 1) mentees learned from their peers' mentoring relationship experiences; 2) mentors enabled learning by scaffolding social comparisons between peers; and 3) mentors could be helpful in promoting peer support.

In her review of the literature on best practices, Risquez (2008) concluded that in conducting an e-mentoring program, the program should go through three phases: 1) design and planning; 2) implementation; and 3) evaluation. She stated that for e-mentoring systems to function effectively, it is necessary to apply the three phases properly. Table 2-1 shows a summary of each phase and its associated factors.

Table 2-1 E-mentoring phases proposed by Risquez (2008)

Phase	Factors
Design and planning	Statement of purpose and long-range plan Relevant populations and stakeholders Contextualisation Technology strategy Promotion and marketing policy Safety measures
Implementation	Recruitment plan Eligibility screening Induction and orientation Coaching Matching and re-matching Monitoring Support, recognition and retention Closure steps
Evaluation	Types of data collected Moment Dissemination

Another review of the literature by Salimi et al. (2017) concluded with a framework for an effective e-mentoring relationship. They applied a qualitative meta-synthesis method to extract the major factors that contribute to building a framework for effective e-mentoring. They extracted four major factors: 1) communication medium; 2) quantity of communication; 3) quality of communication; and 4) communication outcome. The first factor is the type of communication method, its accessibility and its familiarity to the mentor and the mentee. The second factor is related to the frequency of contact, the duration of each session and the duration of the whole relationship. Quality of communication describes the mutual trust, commitment and interest in developing the relationship. It also describes the harmonisation between the mentor and the mentee. The final factor represents the content that has been exchanged between the mentor and mentee, and the goals that have been accomplished through the e-mentoring relationship.

Through this literature review, it has been found that the studies which discussed e-mentoring applications had learning or social theoretical backgrounds. E-mentoring was used as a support mechanism to apply those theories. For example, Yalof and Chametzky (2016) and Rashid and Rahman (2014) used e-mentoring to explore the concept of the community of practice in a learning context, Li et al. (2010) used e-mentoring to support the inquiry-based learning concept, while Savoy's (2013) work on e-mentoring was based on social cognitive career theory. Lamb and Aldous (2014), on the other hand, presented an e-mentoring study based upon the theoretical concept of the pedagogical device by Bernstein (2003).

This review of the literature shows that only a handful of articles presented an e-mentoring model or framework. It also shows the lack of development of models based upon existing e-mentoring models. Lenear (2007) and Williams et al. (2012) in their work identified a lack of developed e-mentoring models. Both studies indicated a rise in literature around the application of e-mentoring programs in comparison to the modest literature around e-mentoring models and frameworks. Lenear (2007) identified some limitations in the e-mentoring literature: the lack of theoretical e-mentoring models and the limited number of research on youth mentoring. While she overlooked Bierema and Merriam's (2002) model, she criticised the broadness of Single and Muller's (2001) model and that their model can be applied to any educational setting, not only mentoring. Similarly, Williams et al. (2012) indicated the need for developed e-mentoring models that cover all relevant factors and dimensions. Williams et al. (2012) did not discuss the models presented above (Bierema and Merriam, 2002; Single and Muller, 2001), but they concluded that due to the nature of applying e-mentoring in different contexts and the fast development of technology, it would be difficult to provide a completely developed model of e-mentoring.

The e-mentoring literature has agreed that e-mentoring relationships and programs must be structured and formatted in order to be successful. According to the presented models and frameworks, there are certain aspects that need to be addressed to establish a successful e-mentoring program and relationships. These aspects include the structure of the program, frequently scheduled communication, administrative support and evaluation. Group e-mentoring has proven to be beneficial in providing peer support and enhancing mentees' mentoring experience by learning from their peers. While the presented works agreed on how to structure e-mentoring, they failed to identify other aspects that may influence the structure of e-mentoring. The cultural attributes of a context might have an effect on the best ways to structure and apply e-mentoring.

2.3   Geographical Distribution of E-Mentoring

Headlam-Wells (2004) in her review of e-mentoring showed that the USA was dominant in the topic and development of e-mentoring, with some other work conducted in Australia, Europe and the UK. Similar to her findings, my review of the literature has shown that e-mentoring work mainly took place in the USA (DiRenzo et al., 2013; Hicks, 2012; Kalisch et al., 2005; Khan and Gogos, 2013; Khare et al., 2013; Lenear, 2007; Mason et al., 1994; Mollica and Mitchell, 2013; Muller and Barsion, 2003; Piliouras et al., 2013; Rhodes et al., 2006; Sanchez and Harris, 1996; Todd et al., 2016; Ware and Ramos, 2013; Wilburn et al., 2009; Wolfe and Gregg, 2015; Yalof and Chametzky, 2016). Modest activity on e-mentoring

has been done in Canada (Letourneau et al., 2012; Li et al., 2010; Stewart and Carpenter, 2009; Wallis et al., 2015), UK (Headlam-Wells, 2004; Headlam-Wells et al., 2006; Hixenbaugh et al., 2006; Lamb and Aldous, 2014; Macafee, 2012; McCall, 2011), Australia (Redmond, 2015; Rickard, 2004; Sinclair, 2003; Woodley et al., 2015) and Malaysia (Dahalan et al., 2011; Fong et al., 2012; Ligadu and Anthony, 2015; Nor and Kasim, 2015; Rashid and Rahman, 2014).

Europe, Asia and South America have also had their share of participation. In Europe, studies have been conducted in Germany (Schimke, 2007; Stoeger et al., 2013), Greece (Petridou, 2009), Hungary (Dorner, 2012; Dorner and Kumar, 2016) and Slovakia (Bacikova, 2014). Other examples were applied around Asia and Africa, for example in China (Wu et al., 2012), Korea (Lee and Noh, 2003), Taiwan (Yang and Liu, 2002) and South Africa (Norodien-Fataar, 2012). Two studies were conducted in South America, specifically in Brazil (Mizukami et al., 2015) and Chile (Quintana and Zambrano, 2014).

In contrast to the growing body of literature on e-mentoring from countries around the world, published work on e-mentoring in the Arab region and specifically in Saudi Arabia is non-existent. One of the gaps that this research identifies is a lack of understanding of the cultural requirements for designing and applying e-mentoring programs in Saudi Arabia and similar contexts.

2.4   E-mentoring Relationships and Contexts

The traditional models for e-mentoring are adult to adult and adult to youth. E-mentoring has been applied in different contexts and served mentees across a wide spectrum of education and profession levels. In some cases of adult-to-adult relationships, undergraduate students were mentored by senior students (peer e-mentoring) mainly to provide support and increase their sense of social integration and student retention (Hixenbaugh et al., 2006; Mollica and Mitchell, 2013; Risquez and Sanchez-Garcia, 2012). Hixenbaugh et al. (2006) discussed student retention and reduction of student withdrawal in a department of psychology. Third year students mentored first-year students through email, which resulted in a greater sense of integration and satisfaction. Mollica and Mitchell (2013) also described an e-mentoring program between junior-level and senior-level nursing undergraduates to tackle the same problem of student retention in nursing. Results reported that e-mentoring helped in reducing students' anxiety, which led to increasing the nursing retention rate. In the study of Risquez and Sanchez-Garcia (2012), the program was open to first-year students from any department to help them with their transition to university. Each mentoring pair had a private asynchronous discussion forum where they communicated for 12 weeks. The results showed

psycho-emotional e-mentoring relationships developed and helped students to build a support network.

In other cases, undergraduate and postgraduate students were mentored by professionals to bridge academia and industry (Khan and Gogos, 2013; Rashid and Rahman, 2014; Wilburn et al., 2009). Wilburn et al. (2009) established an e-mentoring program to overcome the geographical challenge of their campus, which was located in a small town far from major recruiters. Mentors were accounting professionals from large accounting firms and businesses that were in larger cities, and mentees were undergraduate accounting students; they communicated through email. Mentees discussed curriculum choices and career opportunities with their mentors and were able to build their networks and learn about the profession in the real world. Similarly, Khan and Gogos's (2013) program connected biotechnology master's students with professionals in the field; participants communicated through email, online chat or video-conferencing. The program showed an increase in students' interest and satisfaction, and helped them identify their career options. Another e-mentoring program for undergraduates was developed to enhance interior design students' creativity (Rashid and Rahman, 2014). In the study of Rashid and Rahman (2014), students who had below-average grades in their first year were assigned to professional architects via a Facebook group. Comparison between pre-tests and post-tests showed enhancement of students' creativity in designing after e-mentoring.

In another context, some studies described e-mentoring programs for teachers, aiming to professionally develop pre-service, first-year or rural teachers. For example, Mizukami et al. (2015) established an online platform for novice teachers to communicate with experienced teachers. The study evidenced novice teachers' development and the distribution of knowledge between participating members. Redmond (2015) deployed an e-mentoring program that helped rural pre-service teachers in Australia with specific issues and challenges in different fields. For each field, one experienced teacher mentored a group of pre-service teachers in the same field; they interacted through Wikispaces. It appeared that mentees gained knowledge, collected resources and had opportunities to network with their peers. Likewise, another study was conducted in Chile to enhance the development of rural pre-service teachers through email (Quintana and Zambrano, 2014). Participating mentees agreed that the e-mentorship had a positive impact on their skills and practices.

Review of the literature found some e-mentoring relationships that were not common. Plummer and Nyang'au (2009) developed a reciprocal type of e-mentoring that was truly mutual. In this relationship, the two participating individuals took turns in acting as the mentor. For example, a US university professor and the director of a non-government

organisation in Kenya exchanged ideas, plans and experiences to conduct fundraising and research (Plummer and Nyang'au 2009). Another example is an e-mentoring program in Sri Lanka by Gunawardena et al. (2012). They reversed the model of mentoring to accommodate the needs of developing online learning in Sri Lanka. In mentoring, mentors are usually of a similar or older age but not in this context, where young adults mentored older professionals. Since Sri Lanka did not have enough experience in online learning, the project sought international graduates from the USA who were more familiar with online learning than Sri Lankan academics and professionals. The purpose of this project was to train academics and professionals in Sri Lanka to become e-mentors and online tutors through a community-building model. In this project, age did not determine the mentors but their experience with online learning environments. A similar example was presented by Woodley et al. (2015), where university students in Australia mentored small business owners who had little or no ICT skills to support their businesses. Even though neither article (Gunawardena et al., 2012; Woodley et al., 2015) discussed the difference in age between mentors and mentees and whether this had an effect on their relationships, Woodley et al. (2015) showed that the mentors (university students) were encouraged and supported by experienced academic staff. They had to convince the mentors (university students) that they had the ability to perform the role of mentor to business owners who were older than them.

Review of the literature identified only one publication on youth-to-youth e-mentoring (Letourneau et al., 2012). The purpose of the program was to provide online support for young people with asthma from their peers through chat messages, email and bulletin boards. An increase in confidence levels and reduction of a sense of loneliness and isolation among the participating youth were key findings of the study.

E-mentorship programs differ in the connection between mentors and mentees; generally the ties are either one to one or one to many. In one-to-one e-mentoring, a mentor mentors one mentee individually, while in one-to-many e-mentoring, a mentor mentors more than one mentee as a group (Dawson, 2014). The literature shows cases of many-to-many or group e-mentoring, as presented by Kalisch et al. (2005) and Hicks (2012). The single case of youth-to-youth e-mentoring had a one-to-one relationship (Letourneau et al., 2012).

E-mentoring has been applied in different contexts and for different purposes. The previously discussed literature in this section, with their different relationships, contexts and connections, show evidence of the positive effect e-mentoring had on the mentees.

2.5 Means of Communications Used in E-Mentoring

E-mentoring is based on using technology to communicate between mentors and mentees.

Review of the literature shows a variety in communication methods, both synchronous and asynchronous. Email alone was dominant as the most frequently used method of communication in e-mentoring (Hixenbaugh et al., 2006; Janasz and Godshalk, 2013; Lamb and Aldous, 2014; Macafee, 2012; Quintana and Zambrano, 2014; Rhodes et al., 2006; Rickard, 2004; Wilburn et al., 2009). For example, Lamb and Aldous (2014) described an e-mentoring program to support gifted and talented high school students in physical education. For six months, undergraduate physical education students mentored gifted and talented high school students in a one-to-one relationship through email. At the beginning and the end of the program, the mentees visited their mentors on the university campus. Following the first visit, weekly emails were exchanged between mentors and mentees. The data was collected from emails, focus groups and questionnaires. The mentees demonstrated positive feelings towards using email to keep in contact with their mentor. They reported the positive impact of the two face-to-face interactions with mentors, which does not contradict the valuable contribution of e-mentoring in the context. They added that further research should address family support and coaching methods.

Headlam-Wells (2006) noted that the advancement of the Internet and CMC has provided advanced means of communication between mentors and mentees in comparison to earlier examples of e-mentoring which were limited to the use of e-mail between participants. Forums and discussion boards were also used as asynchronous communication methods. Adams and Hemingway (2014) presented an e-mentoring program where plant scientists mentored teams of school students to motivate and encourage their plant investigations. Each team and mentor interacted through a private discussion board. The post-study survey showed that mentors were motivated to inspire and increase students' knowledge of science. The study focused on analysing the content of the conversations to capture the mentors' mentoring techniques. The nature of the communication method used was not discussed in this study.

In publications describing e-mentoring, programs used chat (Letourneau et al., 2012) and video conferencing (Li et al., 2010) as means of synchronous communication. An e-mentoring program for youth with asthma and allergies demonstrated the use of chat sessions to provide social support by older peers with the same medical conditions (Letourneau et al., 2012). The program included the use of chat, email and discussion boards, and it was found that the weekly chat sessions were used more than the other methods. The study focused on the outcomes of the program and reported that follow-up interviews and questionnaires showed the mentees felt more normal and more confident, and had reduced their sense of social isolation.

Another study employed the use of video conferencing to connect mentors with rural secondary school students during their school hours (Li et al., 2010). The study aimed to increase the students' learning in math and science. The findings demonstrated that students were more interactive and more aware of the roles of scientists and mathematicians in real life. The students appreciated that the video-conferenced discussions with the mentors gave them the chance to be heard. The use of video conferencing gave the sense of having real contact with the mentors. Some mentees thought that the use of video conferencing was more exciting than face-to-face meetings. On the other hand, the poor internet connection created some technical difficulty and caused frustration among the students, and some sessions had to be rescheduled. Some students felt discouraged from discussing their comments with the mentors in front of the whole class. The study concluded that the use of technology was a successful implementation in the learning context.

Publications on e-mentoring demonstrated programs that employed one or a mixture of communication methods. As mentioned earlier, some programs used email as the only means of communication between mentors and mentees, while others combined more than one method. For instance, in the study of Lasater et al. (2014) the e-mentoring program for nurses encouraged the use of journaling and email; however, one mentor–mentee pair communicated through audiovisual technology (Skype) to create an electronic face-to-face meeting where they could be open in expressing their feelings and being more empathetic. In the study of Norodien-Fataar (2012), one group of mentors were trained to use existing platforms like learning management systems (LMS), while the second group were encouraged to use Facebook to contact their mentees and the final group were encouraged to use any mean of communication with their mentees. Results showed that mentors from all three groups used Facebook and MXit (the largest instant messaging and social network platform in Africa) more frequently than LMS. One mentor explained that the LMS was not an effective platform for mentoring because his mentee did not know how to use it, unlike Facebook and MXit, which mentees were already acquainted with.

Virtual worlds have become a platform for education and training (Todd et al., 2016); likewise, virtual worlds have been used as a platform to conduct e-mentoring, especially with youth with serious illnesses or people with disabilities (Cantrell et al., 2010; Todd et al., 2016). E-mentoring through virtual worlds was explored to test its role and efficacy for young people with serious illnesses; Zora (Bers and Cantrell, 2012; Cantrell et al., 2010) provided a virtual community for youth transplant recipients with their peers who were experiencing similar circumstances. Mentors helped the participants become more engaged in the virtual communities, provided support and helped them to find ways to cope with their illness. The

use of virtual world was to provide a safe space for the participating youth to develop and explore issues around identity (Bers and Cantrell, 2012). The results indicated that mentees created objects that related to hope, memories and friendship, but these objects did not have a significant effect on the mentees' hopefulness, for example. The findings reported that their parents favoured the use of Zora in comparison to other social media platforms due to its safe context (Bers and Cantrell, 2012). While the virtual world of Zora was a suitable and favourable context for youth (11–15 years old), this was not the case with an older population who used BreakThru. BreakThru (Todd et al., 2016) is a project based on the virtual world of Second Life. Mentoring islands were created in Second Life to advocate STEM to university students with disabilities. The virtual space was the main interaction space between mentors and mentees, but it was supplemented with SMS, Skype, email and Facebook. The results showed that participants mainly used communication methods that they were accustomed to (e.g. SMS and email) and recommended that the use of virtual worlds would be useful as a secondary or supplementary method.

Asynchronous communication methods have the benefit of flexibility in responding, where participants can respond and participate at their convenience (Single and Muller, 2001; Risquez, 2008), and provide a space for discussions to grow and last for longer periods of time (Redmond, 2015). On the other hand, the long time between responses may cause frustration and disconnection in the relationship (Smith-Jentsch et al., 2008). In contrast, synchronous communication requires scheduling and real-time feedback to conduct e-mentoring. CMC in general (synchronous and asynchronous) are perceived as mediums that increase the likelihood of misinterpretation and misunderstanding because of the lack of nonverbal communication cues (Ensher et al., 2003); this can be overcome by the use of audio and video conferencing to make a personal connection (Lasater et al., 2014). However, the lack of nonverbal cues in email and chat, for example, has the benefit of reducing biases in e-mentoring relationships (Ensher et al., 2003).

The advancement of technology presents different means of communications that have been applied in e-mentoring. It was noted that e-mentoring studies with older participants (i.e. undergraduates) were more flexible in choosing the communication method and some even used social media platforms to engage the mentees with the mentors (Lasater et al., 2014; Norodien-Fataar, 2012; Todd et al., 2016). These studies showed that they preferred communication methods that they were acquainted with and used frequently. On the other hand, e-mentoring studies of teenagers and school students used communication methods that ensured the privacy of their mentees; some designed a customised platform (Cantrell et al., 2010) and others used existing technologies or platforms that provided private spaces and

settings for their young participants (Adams and Hemingway, 2014; Li et al., 2010). Private communication methods were favoured by the parents of these participants (Bers and Cantrell, 2012). Therefore, the privacy of the mentees should be taken into consideration when designing e-mentoring programs for young participants.

2.6 STEM E-mentoring for Female Students

Despite a recent increase in interest in e-mentoring, the literature describing research on e-mentoring for young people is not extensive and is spread thinly across programs with different objectives that were applied in a range of contexts and mentee populations (Lenear, 2007; Wallis et al., 2015). While some programs aimed to provide support and guidance about life or career decisions, others focused on skill or academic development; some programs were open to all, while others had specific target mentees such as female students, young people or gifted students. For example, the studies of Rhodes et al. (2006) and Wallis et al. (2015) aimed to promote positive development, prevent behavioural, academic and psychosocial problems, and eliminate school dropout for all students, while in the study of Lamb and Aldous (2014) the aim was to support gifted students in physical education. E-mentoring was utilised in advocating STEM for school students and providing support for STEM post-secondary students. Where all the STEM e-mentoring studies had a general audience for advocating STEM, some studies addressed specific issues and populations. Review of the literature showed that some STEM e-mentoring studies addressed the underrepresentation of women (Lee and Noh, 2003; Reid et al., 2017; Savoy, 2013; Single and Muller, 2001; Stoeger et al., 2013) or individuals with disabilities (Todd et al., 2016; Wolfe and Gregg, 2015) in STEM, while another study addressed the issue of geographical distance for rural students (Li et al., 2010). In this section, the focus will be on studies that were targeting female students.

MentorNet[7] was established in 1997 and is an ongoing large-scale, nationwide e-mentoring community in the USA (Muller and Barsion, 2003; Single and Muller, 2001). It matches female undergraduate and postgraduate students with industry professionals (female or male) for a year-long email-based one-to-one relationship. MentorNet is based on the model of structured e-mentoring (Single and Muller, 2001). MentorNet applies a bi-directional matching algorithm. Based on the choices of the mentors and mentees, the algorithm searches the database and finds the best matches. Regular committed communications between mentors and mentees are expected and communications are set as a

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[7] www.mentornet.net

weekly exchange of emails (Single and Muller, 2001). Online training is mandatory in MentorNet and participants must complete the training materials. Weekly emails are sent to mentees and mentors to remind them to keep communicating and to help them develop their e-mentoring relationship; these emails are considered coaching materials. In an assessment of MentorNet in 2002 (Muller and Barsion, 2003), the results showed that mentees appreciated the support, hope and encouragement received from their mentors. They emphasised the benefits they gained from discussing the challenges of women in STEM with their mentors. Almost 90% of the mentees reported their intention to continue in their STEM fields. On the other hand, mentors indicated their appreciation of the personal satisfaction gained from their participation in MentorNet to share their knowledge with the younger generation (Muller and Barsion, 2003).

At the time MentorNet was established, in the late 1990s and assessed in early 2000, other technologies were not yet founded; this could be the reason why the study did not address the effectiveness of the communication method that was used (i.e. email) as there were no other options, in comparison to later studies mentioned in this section which made use of Skype, Facebook and MOOCs, for example. Recently, it was found on the MentorNet website that the length of the relationship and the communication methods have changed. The length of the relationship has shortened from one year to four months. It is also noted that MentorNet has kept pace with the emerging new communication methods. A YouTube video posted by MentorNet (MentorNet Program Account, 2016) that explains how MentorNet works mentions that mentors and mentees can communicate through on-platform chat, Skype, Google Hangouts, email or other methods of their choice.

In Korea 2001, an e-mentoring pilot study was conducted with a government program called Women into Science and Engineering (WISE) (Lee and Noh, 2003). Bulletin board systems were utilised to encourage female students of all school levels (from middle school to postgraduate) to pursue careers in science and engineering. The key behind using bulletin boards was that the main aim of the pilot study was to gather data about e-mentoring in the context, so bulletin boards were thought of as a good medium for measuring interaction and usage. After matching was done based on participants' area of interests, a bulletin board was set up for each mentor–mentee pair. The mentors and mentees showed some enthusiasm before the pilot study started, yet the results were surprisingly low. One third of both mentors and mentees (33%) wrote zero posts and only 5% of the mentees met the expectation of the study in writing 10 posts. In some cases, mentees or mentors initiated a conversation but did not receive any reply. A mentoring training workshop was held before the study for the mentors, yet 48 out of 111 mentors did not post a single message, which indicates that the

training was insufficient. The post-study survey (answered by 91 out of 143 mentees) showed that mentees had benefited from the program. Based on their study, Lee and Noh (2003) made a number of design recommendations for such approaches to e-mentoring, including: asking mentors to initiate the first post and introduce themselves; suggesting weekly discussion topics to mentors; and active administrative support. Lee and Noh (2003) discussed that the low participation could be due to: technical difficulties; the need for more training; or the fact that the study did not provide any administrative support to participants. In this study, the authors overlooked the wide age range of mentees; while 53.1% of mentees were graduate and postgraduate students, 7.7% were from middle school and 39.2% were from high school (a total of 46.9%). The study did not indicate which age level had no or low interaction. The age range is worth considering when exploring the reasons behind low participation because younger students might not believe in the effectiveness of e-mentoring and so will not interact with the program.

Women in Technology Sharing Online (WitsOn) is an e-mentoring study that utilised a MOOC as a medium for communication in the USA (Savoy, 2013). The choice of a MOOC was based on the high usage of MOOCs among higher education students. Savoy (2013) described WitsOn as different from other e-mentoring studies in that it was not structured and was self-directed. MOOCs are usually used for providing curriculum, but in this study the MOOC was used for making connections; WitsOn connected female undergraduates with professional women. Mentors shared their biographies, stories of their career paths and how they overcame challenges. Mentees and mentors could post questions and initiate discussions. In addition, each week a mentor created a video answering mentees' questions and posted it online for all participants. The findings of an online survey showed that mentees were mostly reading posts rather than interacting or contributing to the content, which is common with MOOCs users. Even with low participation rates, the mentees acknowledged the positive influence of the study on them; the component that had the most effect on them was mentors' career stories, struggles and biographies (Savoy, 2013).

CyberMentor is another example; it was used to advocate STEM to girls in Germany (Stoeger et al., 2013). A total of 800 female students (aged 11–18) participated in a one-year program where each mentee was matched with a female mentor who was either a college student studying a STEM subject or a STEM professional. Mentees and mentors exchanged weekly emails discussing STEM-related subjects. They could also interact through the members-only community platform, which included forum and chat features. The idea of the platform was to promote new role models to the mentees, showing them that their mentor was just one of many successful women in STEM. The program also introduced mentees to other

girls of their age who were interested in STEM. Among the mentees, there was an initial increase in interest in STEM activities and academic elective intentions in regards to STEM subjects. However, while the effectiveness of the program was equated with that of offline youth mentoring, the initially high level of participation by the mentees was not maintained through to the end of the program. It was observed that as the participants became familiar with the mentors and the platform, the number of interactions decreased. This has been identified in other domains; Stoeger et al. (2013) noted that a drop in participation rates after familiarisation is a common issue among online communities. In this study, the length of the relationship (one year) was not explored as a reason for the low participation; since the study showed positive outcomes, it is reasonable to consider that the girls stopped engaging after they had reached a level of satisfaction with the benefits of the program. The same problem of low participation rates was addressed by Savoy (2013) and both studies showed positive outcomes.

Reid et al. (2017) designed a structured program to help first-year female undergraduates who came from low socioeconomic backgrounds in Australia to choose and develop STEM career choices. Each mentee was matched with two mentors, one from academia and one from industry, based on an expression-of-interest survey completed by mentees prior to the program. Nine out of 47 of the mentors were male and the mentees could place a specific request to be mentored by female mentors. In addition, the program uploaded videos of interviews with successful women in STEM talking about their journeys and challenges. A Facebook group was created to facilitate communication between mentors and mentees in an informal setting. Participants also had the freedom to choose their communication method, including face-to-face meetings. Weekly informational emails about mentoring were sent by the program. At the end of the program, mentors and mentees were surveyed and interviewed. The survey results showed that a major increase was found in confidence about choosing STEM career options. The main struggle that was faced by mentors and mentees was to find enough time for the relationship. Results indicated that online communications were the most utilised methods, even among participants who were in the same city. While face-to-face communication comprised 30% of all contacts (137 contacts), Skype was used in 11% of cases and email in 30%. Both the Facebook group and the information emails were found to be very popular among mentees, while only 33% of the mentors found the Facebook group useful. The point of view on usage of Facebook in e-mentoring was not discussed in the study. The generational differences between the mentors and mentees could have contributed to the differences in their perceptions of the usefulness of

Facebook as an e-mentoring channel or it may have been that the mentors did not think of Facebook as a professional medium for communicating with the mentees.

The discussed studies did not present details on the basis of the designed programs or what models they were based on, except for MentorNet (Single and Muller, 2001), which was designed based upon the model of structured mentoring. Even though the presented programs shared the aim of advocating STEM for females, they demonstrate a diversity in communication methods and e-mentoring relationships. Three out of the five programs faced problems in maintaining e-mentoring relationships and suffered from low levels of interaction, but all these studies showed positive outcomes and appreciation from the mentees. Several design implications can be derived from these studies. Most of the presented studies were structured and required frequent communication between a mentor and a mentee (Lee and Noh, 2003; Muller and Barsion, 2003; Reid et al., 2017; Stoeger et al., 2013). Some studies recommended sending informational emails and weekly discussion topics (Lee and Noh, 2003; Reid et al., 2017) and providing administrative support (Lee and Noh, 2003). Same-gender e-mentoring and the feature of sharing the biographies and experiences of STEM female mentors had positive impacts on the female mentees (Savoy, 2013; Stoeger et al., 2013). Group e-mentoring was found to be beneficial in advocating STEM e-mentoring for females because it creates a sense of community and shows the mentees that other girls their age are interested in STEM and are facing the same challenges (Stoeger et al., 2013).

2.7 Mentoring in Saudi Arabia

Traditional face-to-face mentoring programs in Saudi Arabia are uncommon and the existing research literature concerning mentoring in Saudi Arabia is limited and relatively recent (Abalkhail and Allan, 2015; Shukri and Leil, 2017; Sulphey and Allam, 2017). Prior work introduced in this section represents the only examples found of mentoring in Saudi Arabia, indicating that mentoring is not a well-explored topic in this context.

Abalkhail and Allan's (2015) comparative study of female managers' perceptions of mentoring and networking in Saudi Arabia and the UK shed light on their very different concepts, experiences and attitudes towards mentoring. Abalkhail and Allan (2015) noted the lack of mentoring literature in the Arab world, especially in Saudi Arabia, in comparison to the large amount of work conducted on mentoring in the Western context. Their study focused on understanding the differences and similarities between women managers in the UK and Saudi Arabia regarding their views and experiences of mentoring. The results showed that women managers in the two cultures had different experiences and conceptualisations of mentoring. Most of the women managers in Saudi Arabia reported that they had never been in

a mentoring relationship and that they lacked the chance to be connected to a male role model or mentor. On the other hand, most of the female UK managers in the study considered mentoring as an activity that took place in the workplace and had experienced it as such, whereas the female managers in Saudi Arabia considered mentoring as an activity in which they would engage with male family members. Abalkhail and Allan (2015) considered that the reasons for Saudi women managers to depend on their male family members for advancement in their careers could be related to a number of factors: 1) there are no mentoring programs; 2) men and women are physically segregated in the workplace; 3) women in Saudi Arabia have only recently reached higher management positions, which makes finding a female role model or mentor difficult; and 4) Saudi society has a collectivistic nature which provides support and protection for its members.

Health and medical schools are the dominant fields where mentoring in Saudi Arabia has been studied, through understanding students' perceptions about mentoring (Al Qahtani, 2015; Sattar et al., 2017) and presenting the perspective of mentees on their formal mentoring programs (Fallatah et al., 2018; Ghawji et al., 2017). Due to the non-existence of formal mentoring programs in universities, and across Saudi Arabia, Al Qahtani (2015) and Sattar et al. (2017) sought to understand students' perceptions of mentoring with the aim of developing formal mentoring programs. Al Qhatani (2015) studied the knowledge and perceptions of master's students towards developing a mentoring program, and Sattar et al. (2017) studied the views of medical students regarding mentoring and mentors. Al Qahtani (2015) showed that 92% felt the need for a mentoring program and 60% had positive attitudes towards mentoring. Similarly, Sattar et al. (2017) showed that almost 87% of the students stressed the need for having a mentor during their medical studies. Regarding their knowledge of mentoring, 70% ranked their knowledge from moderate to very good (Al Qahtani, 2015). In the study of Sattar et al. (2017) participants described the mentor's role as that of a "guide". Al Qahtani (2015) showed that there were no gender differences in the perceptions and attitudes towards mentoring and developing a mentoring program. Sattar et al. (2017) documented that the majority of students did not think that the gender of the mentor was important, while 30% reported that it was important to have a mentor of the same gender. Overall, both studies highlighted the students' need for mentoring during their studies and documented positive attitudes from the participants towards mentoring.

Ghawji et al. (2017) reported on a Saudi university mentoring program in which undergraduate medical students (of both genders) were assigned to a mentor (faculty member) at the beginning of their first year for academic and career-planning guidance and support. They highlighted the lack of studies on structured mentoring in Saudi Arabia, which

generated a gap in understanding and evaluating the effectiveness of such programs. Some resistance was found at the beginning of the program from the mentors. The program director and the college dean discussed with the mentors the importance of mentoring, their roles and the mandatory meetings with the mentees. An email was sent to the mentees that specified the program's goals and their responsibilities. The results showed no differences in responses between male and female students. However, it was found that many of the mentees never met their mentors. Third-year students had the most positive attitudes towards mentorship in comparison to students from younger years. It was clear that first-year and second-year students did not value the importance of mentoring, nor knew what they would gain from their relationship with their mentor. Ghawji et al. (2017) believed that third-year students during their study went through passive training that developed them into good mentees who had better relationships with their mentors. They concluded that communication and motivation were the main aspects of a successful mentoring program.

Likewise, Fallatah et al. (2018) conducted a mentoring program for fourth-year female undergraduate medical students to understand the characteristics of mentors that contribute to the development of mentees' academic performance. The study was initially designed for females because at the university the male and female students had different cohorts with different curricular structures. Each faculty mentor was assigned 10 mentees, where they had group and one-to-one meetings. One day of training was held for mentors. A survey was sent to mentors to measure their views on the importance of mentoring and their interest in participating. Based on their answers, mentors were classified into motivated mentors (52%) and unmotivated mentors. Mentees' attendance (group and one-to-one meetings) was higher with motivated mentors than with unmotivated mentors. Results showed advancement in the academic performance of mentees who attended the meetings regularly. The selection of the mentors was not an option by the mentees, which may have contributed to the low attendance rate in mentees with unmotivated mentors. The seniority of the mentor was a favourable factor for the mentees. In addition, the level of motivation and interest of the mentor had an impact on the effectiveness of the mentoring relationship. Overall, most of the mentees (83%) had positive thoughts about mentoring and believed in its values and benefits. Older students tended to value mentoring more than younger students (Fallatah et al., 2018; Ghawji et al., 2017).

On the other hand, Shukri and Leil (2017) reported the results of a peer mentoring program in an English language institute in Jeddah that aimed to help new teachers with their professional development and ease their transition to a new work environment and a new culture. The mentees were new female teachers from different Western nationalities who

came to work at an English language institute on a female university campus. The study questioned eight mentees and most (75%) agreed that mentoring eased their process of adjusting to a new culture and a new profession. All the mentees agreed that mentoring was a significant factor in overcoming the challenges of their new environment, especially cultural misunderstandings. They also agreed that observing their mentors helped them improve their teaching skills.

In all the studies reviewed, there was an emphasis on the non-existence of mentoring programs or literature in their fields prior to their attempts. They also emphasised the need for mentoring programs because previous literature in other contexts had proven the effectiveness of mentoring programs, so they stressed that these attempts were worth replicating and conducting in the Saudi context. From a cultural perspective, Fallatah et al. (2018) explained that their study was limited to females mentors to avoid the cultural challenges that might occur from having male mentors mentoring female mentees. On the other hand, Sattar et al. (2017) reported that only 30% of their participants were concerned with the gender of the mentor and preferred same-gender mentoring. While the literature around mentoring in Saudi Arabia is limited, most of these published studies have not addressed the cultural aspects of the context of Saudi Arabia and how culture might affect the application of mentoring. This presents a gap in research for further exploration about the role of Saudi in applying mentoring and e-mentoring.

2.8 Summary

This chapter has reviewed the limited number of published works that presented e-mentoring models or frameworks. The presented work agreed that for successful e-mentoring relationships, e-mentoring programs should be structured and require frequent scheduled interactions between mentors and mentees. Cultural requirements for designing and applying e-mentoring programs in Saudi Arabia have not been discussed in the literature due to the lack of published work on e-mentoring in Saudi Arabia or similar contexts.

While this review of the literature has found only a handful of articles that applied e-mentoring to advocate STEM for females, several recommendations for designing STEM e-mentoring have been identified. These recommendations are: (1) committed relationships, managed expectations, and regularity of contact between a mentor and a mentee (Bierema and Merriam, 2002; Single and Muller, 2001), (2) sending informational emails and weekly discussion topics (Lee and Noh, 2003; Reid et al., 2017; Single and Muller, 2001), (3) providing administrative support (Lee and Noh, 2003), (4) same-gender e-mentoring and group e-mentoring (O'Neill, 2004; Savoy, 2013; Stoeger et al., 2013), and (5) the use of

communication methods that created a private space for the mentor and mentee relationship (Adams and Hemingway, 2014; Bers and Cantrell, 2012; Li et al., 2010).

In conclusion, three factors will be addressed in this research: the context of Saudi Arabia, targeting females and the young age groups of the participants. This chapter has reported a gap in the literature about Saudi Arabia regarding the non-existence of e-mentoring programs and the lack of understanding of the role of culture in e-mentoring. Therefore, this research aims to identify which factors are important in the design of STEM e-mentoring for teenagers and young women in Saudi Arabia.

Chapter 3 Methodology

3.1   Introduction

Due to the lack of prior research on e-mentoring in Saudi Arabia, this research was
exploratory and interpretive in nature. Stebbins (2001) mentioned that researchers carry out
exploratory research when "they have little or no scientific knowledge about the group,
process, activity, or situation they want to examine but nevertheless have reason to believe it
contains elements worth discovering." Exploratory research in design gives a good
understanding of the people and the issues that are being examined and typically ends with
implications for design (Hanington, 2010). Because of the lack of previous work on e-
mentoring in Saudi Arabia, user involvement in the process was essential in understanding the
needs and requirements of e-mentoring in the Saudi context, therefore user-centred design
(UCD) approach was adopted in this work. User-centred design is an approach for
incorporating end-users in the design process and giving them a sense of ownership of the
final product (Abras et al., 2004). It involves a variety of methods, including field studies,
observing and analysing tasks and requirements, prototyping, user interviews, usability
evaluation, surveys, and co-design (Vredenburg et al., 2002).

Exploratory research tends to be qualitative in nature, supplemented with quantitative
data (Hanington, 2010; Stebbins, 2001). The qualitative approach was mainly applied in this
research, supported with quantitative data to gain an understanding of e-mentoring in the area
of the study. HCI research has turned from using measuring instruments and generating
numbers to understanding users' motivation, needs and social norms, and how they think and
feel (Adams et al., 2008). In HCI, qualitative methods are essential for understanding the area
and users, gathering requirements and evaluating (Adams et al., 2008; Blandford et al., 2016).
In this research, several UCD methods were used to elicit data and requirements including
interviews, pre-study and post-study surveys, focus groups, co-design workshops and
observation of interactions and posts written by participants. This research was conducted
through exploring the context with a pilot study, gaining insights and requirements for design
through co-design workshops, and design and evaluation of the new design (Table 3-1).
Design methods for each study are described in more detail in the following chapters.

This chapter begins by presenting related work on co-designing and teenagers
showing the significant difference in research design when working with teenagers compared
to other ages. Later, it describes the UCD methods used in this research.

Table 3-1 Studies conducted in this research

Study	Purpose	Research question	Data collection
Study 1 Pilot study	Explore structured e-mentoring in the Saudi context	RQ1	phone interviews, online pre- and post-study surveys, online focus groups, numbers and content of posts, written by participants
Studies 2 & 3 Co-design workshops	Collecting design requirements	RQ2	problem statement stories, bodystorming, paper prototyping, designing the box, online surveys
Study 4 Qudwa	Build a design based on the collected requirements, deploy it and evaluate it	RQ3	phone and WhatsApp interviews, online survey, observation of interactions, submissions by participants, analytics from social media promotions

3.2 Related Work: Co-design and Teenagers

Designing with adults and children has been the focus of HCI research and between these two populations lies the understudied population of teenagers (Fitton and Bell, 2014; Poole and Peyton, 2013; Read and Horton, 2016; Yarosh et al., 2011). Teenagers go through fundamental cognitive, biological, emotional and social changes in their transition from childhood to adulthood, and these changes have attracted the attention of few researchers in addressing their special needs and understanding the challenges in HCI and co-design related to this population (Fitton et al., 2013; Poole and Peyton, 2013; Yarosh et al., 2011). Their semi-tribal behaviour of moving in groups makes them a distinct and interesting user group and culture (Read and Horton, 2016). With their creativity and early adoption and use of technology, teenagers can provide different and innovative perspectives in developing digital solutions as they embrace technology in their own way to meet their own needs (Read and Horton, 2016).

In recent years, HCI communities have started to publish work on understanding teenagers (Fitton and Bell, 2014; Read and Horton, 2016), with data collection and methodologies suited to teenagers (Poole and Peyton 2013), as well as working with teenagers as designers (Ashktorab and Vitak, 2016; Mazzone et al., 2008; Vacca, 2017). Fitton and Bell (2014) reported that to understand teen development, three aspects should be taken into

consideration: 1) the cognitive, biological and social changes that happen in teenage years; 2) the social environment the teenager exists in; and 3) the psychosocial changes, which are both social and psychological (Fitton and Bell, 2014). Teens occupy a cultural space which is distant from that which adults occupy and this distance from the adult culture increases the autonomy of teenagers, but on the other hand creates problems in communication between adults and teenagers (Read and Horton, 2016).

Poole and Peyton (2013) discussed how traditional qualitative methods when designing for adults and children help in capturing their needs and requirements, while these exact methods can be a problem when working with teenagers due to the differences between adults, teenagers and children. In interviews, answers in some cases are limited to 'yes' or 'no' because the teenager sees the researcher as an authority who has power over them or feels discomfort with the researcher. Some suggestions to overcome this problem include using computer-assisted self-interview methods or giving the teenager the power to choose the interview location. On the other hand, focus groups were found to be helpful with teenagers (Poole and Peyton 2013). The benefits of focus groups for teenagers originate from the presence of peer support, social interaction and the advantages teenagers have over adults in their knowledge about their peers.

Literature on co-design and participatory design methods have been applied with different groups of teenagers. In their work around preventing cyberbullying in teenagers, Ashktorab and Vitak (2016) discussed the challenges and solutions for cyberbullying prevention in working with teenagers. They conducted five design sessions over a period of five weeks with high school students. The sessions consisted of focus groups, scenario centres, bags of 'stuff', mixing ideas and evaluating prototypes. Participants in the final design session were asked to reflect on their experience with co-designing. Participants appreciated the opportunity to be involved in creating solutions for a problem that affected them or people around them. The novelty of working with adults as equal design partners was an exciting aspect of the experience for them.

Vacca (2017) worked with Latina teenagers to explore the role of technology in providing emotional support. In this work, participatory design was used to understand the cultural identity and Latina emotional support system. A total of eight sessions were conducted with 13 Latina teenagers recruited through social media and afterschool activities. Participants explored emotional health, discussed scenarios, engaged in brainstorming and prototyping sessions, and reflected on the process. The findings emphasised that their non-singular cultural identification (biculturalism) and living in two cultures played an important role in participants' technological designs for Latina emotional support.

Another study with disaffected teenage students presented the challenges faced in working with this specific user group (Mazzone et al., 2008). The purpose of the study was to develop a computer game with the involvement of disaffected teenagers to teach them how control and understand their emotions. Due to the lack of experience and lack of previous work on designing with a user group characterised by disruptive behaviour, Mazzone et al. (2008) had to conduct a couple of sessions before learning the best way to approach the participants and conduct the design sessions. Certain aspects of the participants, such as short attention spans, low motivation, critical behaviour and unpredictable attendance, forced the researchers to adapt and shape the sessions around the participants. Similar to the study of Ashktorab and Vitak (2016), it was found that the participants were excited to be given the opportunity to be part of designing a video game and they felt responsible. The researchers concluded that the design sessions contributed not only to the final design, but also to improvement in the behaviour of the participants and their progressive engagement in the sessions.

Co-design was also employed to understand the feelings of teenagers with diabetes (Glasemann and Kanstrup, 2011). Glasemann and Kanstrup (2011) aimed to gain insight into how these young people felt about their illness. The participants were supplied with a pack filled with different materials including glue, pens, a polaroid camera, a paper prototype of a personal digital assistant and modelling clay to help them mock up mobile diabetes supporters. The participants worked on their mock-ups for 45 minutes, followed by a presentation session. There were 12 mock-ups as a result of the design session. Glasemann and Kanstrup examined how the participants presented themselves through the designs as young and diabetic. Their examination resulted in addressing three themes: identity; the burden of dealing with their illness on a daily basis; and connectivity. The authors sought to understand the emotions and feelings behind the designs. They stated that it was as if the participants used a different language to express their emotions that could be described as a "particular sort of partly unconscious communication" (Glasemann and Kanstrup, 2011, p. 129). The study concluded that teenagers through co-design could express themselves and their feelings, and that it was a valuable method for understanding them.

Of particular relevance to this research, my review of e-mentoring literature identified only one article that included mentees aged 15–21 (middle and high school students) in a co-design activity and this only focused on the "visual" design of a website (Kalisch et al., 2005). Kalisch et al. (2005), in their program to advocate nursing as a career choice, connected students with volunteer nurse mentors. The initial design of the of the mentoring website was a joint effort between the research team of nurses working on the project and the web

developers. One key aim was that the website was attractive to the target age group. Therefore, the web developers visited schools to give students the opportunity to improve the look of the initial design (i.e. the colours, adding pictures and rearrangement of components). In this regard, through this research it was found that co-design activities and participatory design methods have not been addressed in designing e-mentoring with teenagers, particularly in the Saudi context.

3.3 Methods

3.3.1 *Recruitment*

The principal participants in this research were the mentees and the mentors. The recruitment purposes for mentors and mentees are different, therefore different approaches were used to recruit mentors and mentees. To recruit mentees, announcements were made through three channels: 1) a public scientific event (Genuino Day 2016); 2) schools and university; and 3) social media channels. One approach to recruit mentees and mentors for Study 1 (the pilot study) was to call for participation at Genuino Day 2016. This event was dedicated to females only with attendees of different ages. I gave a brief talk about e-mentoring and attendees who wanted to participate as mentors or mentees provided their information. School visits helped in recruiting mentees for Study 1. Participants in Study 2 (the co-design study) were recruited from the university mail list and the co-design workshops were conducted there. Study 3 (the other co-design study) was conducted on a school campus with school students. Single and Muller (2005) suggested the use of electronic communications in recruitment since e-mentoring is based on electronic communications. The final channel was to call for participation through social media networks such as Twitter, WhatsApp and Instagram, as they have been found to be tools to overcome the challenges that researchers face in research recruitment (Gelinas et al., 2017). Social media platforms with their advertisement settings provide specific targeting options such as age, location, gender and interests, and are a popular method to target hard-to-reach populations (Guillory et al., 2018). In Study 1 and Study 4, I broadcast an announcement to WhatsApp groups and individuals, and asked them to forward the announcement to their own contacts. Promotions on Twitter and Instagram were used for the recruitment and announcement of Study 4.

LinkedIn was mainly used for recruitment of mentors to overcome the challenges that were faced in finding Saudi STEM female professionals; not because of a lack of such professionals, but because of the absence of their visibility and communities, and networks of Saudi female professionals. I searched for Saudi female STEM professionals and approached them with the projects' aims and objectives. I also utilised my personal contacts to find

potential mentors. Professionals who agreed to be mentors recommended others through snowball recruitment.

3.3.2 *Surveys, interviews and focus groups*

Surveys, interviews and focus groups are commonly used methods in HCI (Lazar et al., 2010). Since the early years, surveys have been a main method for data collection in HCI (Sears et al., 2007). The popularity of surveys in HCI comes from their characteristic of being an easy-to-use tool that helps in gathering an overview of users' satisfaction, opinions, ideas and evaluations regarding a system (Lazar et al., 2010; Sears et al., 2007). In Study 1 (the pilot study) pre-study surveys were filled out by the mentees and their parents which included demographic data and their past experiences and expectations of mentoring and e-mentoring. The post-study survey was conducted to evaluate the pilot study. In Study 2 and Study 3 (the co-design workshops), the surveys collected demographic data about the mentees and their access to female role models. In Study 4 (*Qudwa*), the post-study survey was used as an evaluation method to evaluate the developed design from three perspectives: the nature of the relationship, communication channels and the impact of *Qudwa* on them.

Direct discussions with the participants or users provide deeper insights and understanding. Interviews and focus groups are useful for gathering requirements and evaluations of systems (Lazar et al., 2010). Semi-structured interviews are useful when little is known about the topic of investigation and to obtain deeper insights and design requirements (Lazar et al., 2010). In Study 1, semi-structured interviews were conducted by phone with mentors, mentees and parents. Interview questions concerned the respondents' participation in the e-mentoring program in general and also focused on the barriers and benefits of their experience with e-mentoring. Study 1 was designed to keep parents involved, yet none of the parents participated. It was essential to understand the parents' views, opinions and reservations about e-mentoring. An online focus group with some of the mentees supplemented the interviews in helping to initially understand their needs and requirements. At the end of Study 4 (*Qudwa*), semi-structured interviews were also conducted with mentors and mentees to discuss their experience with *Qudwa* and e-mentoring.

3.3.3 *Co-design methods*

Design practice has been influenced by changes in the perspective on user-centred design research. User-centred methods are most beneficial when designing products for users, but nowadays designers are designing for experiences, cultures and communities of people (Sanders and Stappers, 2008). Therefore, co-design has shifted from designing products for

users to designing for people's experiences and purposes. This shift has changed the role of the user from a passive role in user-centred design to an active role in the co-design approach (Sanders and Stappers, 2008). In co-design, the people who will benefit from the design (the users) play a large role in gathering knowledge and generating ideas; they play the role of the 'expert on their own experience'. User participation in technology co-design aims to elicit knowledge and ideas from expert users who know the problem and have been in the relevant situation (Vines et al., 2013). In addition, co-design gives power and agency to those who are usually ignored in the process (Vines et al., 2013). Giving power and agency to people to participate in the design of systems they will use results in successful participation in design by incorporating their understanding of the challenges and barriers. In Study 2 and Study 3, the employment of co-design workshops was intended to empower the target population in addition to gaining a deeper understanding of the perceived barriers to and opportunities for e-mentoring from their point of view. Four co-design methods were conducted: problem statement stories, bodystorming, paper prototyping and designing the box.

In Study 2, the first workshop was intended to introduce the problem space to the participants. I used an animated video to tell a story, which in the research phase of the design process is known as "problem statement stories" (Gruen et al., 2002). Stories are tools used to encourage others to consider relevant or similar situations from their own experience. Most people understand and empathise with stories that have detailed characters, settings, goals and challenges. Empathising with stories prompts innovation and creativity (Gruen et al., 2002). The second workshop used bodystorming as a method to make the concept of mentoring more tangible to the participants. The role of acting in bodystorming helps to support empathy towards users and helps in them becoming familiar with unfamiliar situations, which results in better understanding of the problem (Oulasvirta et al., 2003). Rather than using familiar alternatives such as personas, participants were asked to play the roles of the mentor and the mentee to support their understanding of e-mentoring and the production of ideas for realising it (Schleicher et al., 2010). In the final workshop, the participants engaged in a process of low-fidelity prototyping using paper. The aim was not to produce detailed user interface designs, but to complete their understanding and validate the ideas generated in the previous workshops. Paper prototyping with young users is a preferred method for capturing, understanding and reflecting on the requirements and needs of the young participants (Glasemann et al., 2010).

In Study 3, the goal of the co-design workshop was to design an e-mentoring product that expressed the e-mentoring experience that the participants desired. The purpose of this activity was to translate participants' ideas and needs onto a physical object, 'the box'. This

box is a medium where information is physically presented (Gray et al., 2010). The outcome of this workshop was a box which captured and reflected the needs of the participants (Wienhofen et al., 2014). Wienhofen et al. (2014) described the outcome of this activity as a product that gives prospective users the "I want this and I want it now" sensation.

3.3.4 *Thematic analysis*

Thematic analysis (Braun and Clarke, 2006) was applied to all qualitative data: posts, interviews (with mentees, mentors and parents), focus group discussions and presentations. Thematic analysis is useful in participatory or UCD research where users have an active role in the process (Braun and Clarke, 2006). Since this research applied UCD methodology, thematic analysis was applied to help better understand the intended users.

In Study 1, Study 2 and Study 4, I applied the inductive approach to thematic analysis (Braun and Clarke, 2006), a bottom-up method where data coding is conducted regardless of researchers' assumptions. It is considered a data-driven methodology because themes originate from the content of the data. I studied the data, generated themes and validated them with my supervisory team.

For the data from Study 3, I applied deductive thematic analysis (Braun and Clarke, 2006), which is analyst-driven. Study 3 was conducted to validate the findings from Study 2, so the themes emerging from Study 2 were the basis of the deductive thematic analysis. All Arabic text was translated and is marked with an asterisk (*) at the end of the quotes.

3.4 Summary

Due to the exploratory nature of this research, user-centred design methodology was applied to explore and understand the users, their requirements and the context. Previous work showed how research design differed when working with teenagers compared to other age groups. It has also addressed the lack of applying co-design methods in designing e-mentoring programs for teenagers. Therefore, this research aims to apply several UCD methods in order to identify which factors are important in the design of STEM e-mentoring for teenagers and young women in Saudi Arabia.

Chapter 4 Pilot Study: Structured E-mentoring

4.1 Introduction

Due to the lack of research about e-mentoring in the Arab region and the Saudi context specifically, I have carried out a pilot study to explore the attitudes and behaviours of young Saudi women (16–18 years old) towards a structured e-mentoring program. The aim was to understand the feasibility of, and barriers to, the use of existing online platforms as a vehicle for female Saudi STEM role models to mentor young women in Saudi Arabia with the goal of increasing their interest in STEM careers. The research question addressed in this chapter is exploring the potential for applying a STEM e-mentoring program for teenagers and young women in the Saudi context.

The review of the literature in Chapter 2 concluded with several recommendations for designing STEM e-mentoring programs. In previous e-mentoring literature, there was a consensus that e-mentoring relationships and programs have to be structured and formatted to be successful. Bierema and Merriam (2002) stressed that certain factors must be in place in order for e-mentoring relationships to be successful. These factors are committed relationships, managed expectations and regularity of contact between a mentor and a mentee. In her review of the literature on best practices, Risquez (2008) divided e-mentoring programs into three phases: 1) design and planning; 2) implementation; and 3) evaluation. She stated that in order for e-mentoring systems to function effectively, it is necessary to apply the three phases properly. In a more detailed format, Single and Muller (2001) presented a model of structured e-mentoring. The model consisted of three phases: 1) planning; 2) structured implementation; and 3) assessment. In the planning phase, the overall idea of the e-mentoring program is developed, from identifying the participating population and matching process to setting program goals. The second phase is structured implementation, which is influenced by the program goals and is intended to aid the participants to make the most of their participation. The final phase focuses on evaluation of the program. Single and Muller's (2001) assessment involves collecting three types of data for evaluation: involvement data, formative data and summative data.

E-mentoring studies for young participants ensured the use of communication methods that created a private space for the mentor and mentee relationship (Adams and Hemingway, 2014; Bers and Cantrell, 2012; Li et al., 2010). STEM e-mentoring studies for females were structured and required frequent communication between mentors and mentees (Lee and Noh, 2003; Muller and Barsion, 2003; Reid et al., 2017; Stoeger et al., 2013). Sending informational emails and weekly discussion topics, and providing administrative support were

recommended for the design (Lee and Noh, 2003; Reid et al., 2017). Same-gender e-mentoring and group e-mentoring were favourable in advocating STEM e-mentoring for females (Savoy, 2013; Stoeger et al., 2013).

Given the lack of e-mentoring research and practice in Saudi Arabia, the initial design of this study was based on the lessons learned from the literature, the recommendations on e-mentoring programs for young people in other contexts and the following cultural assumptions: the use of textual communication for privacy and parents' involvement. The selection of textual communication as the mean of communication was based on maintaining the privacy of the female participants (Al-Saggaf, 2011). Parents' involvement has been considered an external factor that contributes to the effectiveness of face-to-face mentoring programs (DuBois et al., 2002; McDaniel and Yarbrough, 2016). DuBois et al. (2002) in their evaluation of face-to-face mentoring programs for youth reported that programs which supported parents' involvement showed a larger effect size than other programs. Therefore, the design choice to involve parents was because mentoring is not a familiar concept in Saudi Arabia and therefore parents might have concerns about their daughters talking to professionals they do not know, as well as increasing the effectiveness of the e-mentoring program.

In this study, I have followed Single and Muller's (2001) model of structured e-mentoring in conjunction with recommendations from previous studies on structured e-mentoring (Bierema and Merriam, 2002; Risquez, 2008) and lessons learned from previous e-mentoring studies.

4.2 Method

4.2.1 *Platform selection*

In this study, the search was for a platform that creates a free, safe online environment that supports textual communication (including Arabic) between participants and allows the involvement of parents. When it comes to mainstream social platforms, Facebook is the most popular social network, reaching one billion active users (Greenhow and Askari, 2017), and has been used as an e-mentoring platform (Rashid and Rahman, 2014; Ware and Ramos, 2013). Even though Facebook is popular worldwide, this is not the case in Saudi Arabia (Alwagait et al., 2015). Facebook has been criticised for its vulnerabilities in terms of privacy. Therefore, for educational purposes, other social networks such as Edmodo and Ning have been suggested as safer alternatives (Thongmak, 2013).

Ning is a commercial platform that allows the creation of your own social network. Ning provides a 14-day free trial. Hicks (2012) used Ning to create La Cuna, an e-mentoring

platform for the professional development of librarians. At the beginning of the study, Ning was a free platform. Over a period of six months, 38 librarians joined the forum and nine discussions were written within the first month, with an average of two comments per discussion. Hicks described participation rates as low in comparison to the number of participants. Results showed that seven participants were passively participating in La Cuna and four did not interact with La Cuna in any way after signing up. The timing of the study (the middle of the academic year), participants' perception of expertise (whether they considered themselves mentors or mentees), the manual setup of email notifications for new discussions and replies, and the surprising discontinuation of free access to the platform were the reasons that the e-mentoring program failed.

Edmodo is a free and secure platform available both as a web-based tool and as a mobile application that facilitates an educational social network aiming to connect teachers, students and parents (Figure 4-1). It looks like Facebook, but for educational purposes it is more secure and private, as it enables teachers to create and manage accounts, and only their students who are given a *Group Code* can access and join the group. Parents can also sign up and use a unique *Parent Code* that is accessed in their child's Edmodo account. Similar to Ning, Edmodo has been used as a platform for e-mentoring (Scott, 2013); that project was designed to provide fifth and sixth grade girls interested in science with the opportunity to communicate online with successful STEM female professionals. Edmodo was successfully used as an e-mentoring platform, resulting in a positive impact on girls and helping improve their attitudes towards science and interests in STEM. It was shown that the participating girls enjoyed Edmodo's format, ease of use, safety and security.
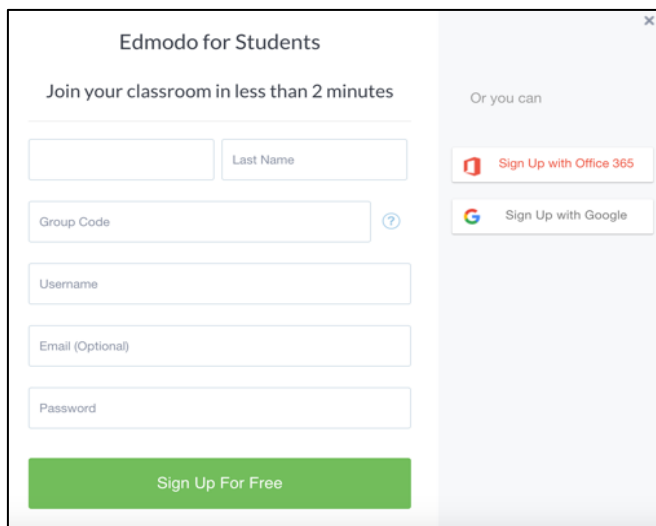
Figure 4-1 Edmodo home page allows creating accounts for teachers, students and parents

Edmodo has been employed in other educational settings in Saudi Arabia (Al-Kathiri, 2015; Al-Said, 2015). Al-Kathiri (2015) examined the prospect of integrating Edmodo into the instruction in a Saudi EFL (English as a Foreign Language) female high school. It focused on the perceptions and challenges of students concerning the use of Edmodo and its impact on their attitudes towards EFL learning. Study findings showed that using Edmodo improved the attitudes of female Saudi students towards EFL learning in comparison to learning the traditional way. Al-Said (2015) measured undergraduate students' perceptions of Edmodo and m-learning (mobile learning) in a Saudi university. Findings also showed that the perceptions of students towards Edmodo and m-learning were generally high and most students believed that learning with Edmodo facilitated and increased the effectiveness of learning communication and they appreciated Edmodo because it saved time.

Even though Edmodo is not generally used for e-mentoring, it fulfilled the context-specific requirements of this e-mentoring structured program in two respects. First, it supports textual communication (including Arabic) between participants while maintaining the privacy of participants. Second, it provides a safe and secure online environment that allows the involvement of parents. The familiarity of Edmodo in the Saudi context and its safe environment, involvement of parents and emphasis on collaborative content and social networking appeared to make it the best fit for this study.
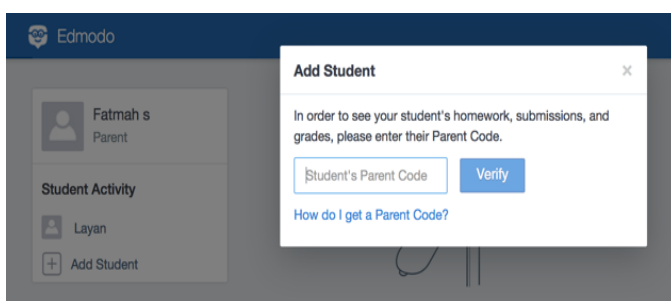
Edmodo is designed to be a safe forum-like platform that allows the creation of private groups, where each group has a Group Code that is required for access (Figure 4-2). Edmodo can be accessed through both a web-based interface and a mobile application. Teachers create a group and share the Group Code with their students. Teachers can also assign another teacher as a co-owner of the group. Edmodo allows teachers the ability to manage members of their groups and monitor group membership. When a student requests to join the group, the teacher will receive a notification. Once all required students have joined a teacher's Edmodo group, the teacher can lock the Group Code so that no other students can join.

Figure 4-2 Student registration form shows field for Group Code

Parents/carers/guardians (PCGs) can sign up and use a unique Parent Code (which is different to the Group Code) to access their child's Edmodo account (Figure 4-3). Teachers have access to the Parent Codes associated with the members of their group. Students and teachers can create, reply to and 'like' posts. Posts are either visible to all members of the group or private between a teacher and a student. Edmodo does not allow student–student private messaging. All discussions that take place in a group are public and supervised by the teacher who created the group; PCGs have read-only access to all posts written in their children's groups and they can also view all private messages that their child writes or receives, but cannot send or receive messages.

Figure 4-3 Parents can add their children by submitting a Parent Code obtained from their children's Edmodo accounts

4.2.2 Recruitment

The principal participants were the mentees and the mentors. The recruitment purposes for mentors and mentees were different, so over two months different approaches were used to recruit mentors and mentees. To recruit mentees, announcements of the program were made through three channels: 1) school visits; 2) Genuino Day; and 3) social media channels. I started by visiting girls' schools in Riyadh and talking to the administration. One school

which believed in the importance of the project agreed to let me talk to their students. The school set a date and time for me to visit and talk to the students. The school administration thought that grade 12 (high school) students were the target group that was in most need of the help provided by the project. I introduced myself and the project's purpose, and talked with the students about their plans. At the end of the meeting, I distributed information sheets about the project and consent forms to be collected on a later visit. Another approach was to call for participation at Genuino Day 2016. Genuino Day is an event held worldwide for the Genuino and Arduino communities. The Women's Program at King Abdulaziz City for Science and Technology held the event in 2016 and it was dedicated to females only, with attendees of different ages. At that time, I was assigned as the Mentoring Coordinator of the Saudi Arabian Chapter of Arab Women in Computing (ArabWIC) from January 2016 until January 2017. The Chapter was participating by presenting a talk by its coordinators and running a standalone booth. I gave a brief talk about mentoring and the Chapter, and had the chance to present the e-mentoring project. At the booth, attendees who had attended my talk and others asked about the e-mentoring program. Attendees who wanted to participate as mentors or mentees provided their information. Information sheets and consent forms were sent to them by email.

Single and Muller (2005) suggested the use of electronic communication in recruitment, since e-mentoring is based on electronic communication. The final channel was to call for participation through social media networks such as Twitter and WhatsApp. I broadcasted the announcement to WhatsApp groups and individuals, and asked them to forward the announcement to their own contacts, including King Saud University staff and student email lists. People who were interested contacted me by email or phone. I explained the project to them, answered their questions and sent them information sheets and consent forms by email.

In this phase, the challenge was finding female Saudi STEM professionals, not because of a lack of such professionals but because of their lack of visibility and the lack of communities and networks of female Saudi professionals. I used LinkedIn as a professional network to look for members with appropriate profiles. I searched for female Saudi STEM professionals and approached them with the project's aims and objectives. I also utilised my personal contacts to find potential mentors. Professionals who agreed to be mentors recommended others through snowball recruitment. Information sheets and consent forms were sent to all potential mentors.

4.2.3 *Matching process*

By the start of the study, the recruitment resulted in 22 Saudi girls aged 14–17 from different provinces in Saudi Arabia and 17 Saudi women mentors from a range of STEM professions. Although the parents of the mentees were offered the opportunity to join the program, none chose to do so. The participants (mentors, mentees and parents) took part in the study voluntarily, with the option to withdraw at any time during the study. Information sheets about the study, data collection and data privacy were distributed to all participants. I encouraged the participants to ask questions before and after joining the study. Consent forms were collected from all participants.

I applied the participant-choice matching method (Single and Muller, 2001). In doing so, I sought to strike a balance between privacy and appropriateness by involving a trusted intermediary (myself) to mediate the connection between mentors and mentees. The aim was to expose the mentees to the variety of STEM career options available to them by displaying the group of participating mentors. To maintain the privacy of the female mentors, I applied Single and Muller's (2001) recommendation not to reveal any contact information of the mentors. That is, all the choices made by the mentees were sent to the intermediary (myself).

First, I asked the 17 mentors to write a short descriptive profile about themselves and their work, using accessible language, that would attract mentees. It is not customary for Saudi females to post their own photos publicly on the internet (Guta and Karolak, 2015); therefore, I asked the mentors to pick an image of a cat that would represent their work. The use of cat images was also intended to lessen the formality between mentors and mentees. Later, I sent the collected 17 profiles, with the associated cat images, to the mentees via email and asked them to choose their mentors. As the goal was to have no more than five mentees in each mentor's group, I asked each of the mentees to choose three mentors and rank them in descending order based on their personal preferences. Mentees were then organised into groups based on their selection of mentors. This resulted in choosing eight out of 17 mentors from a range of STEM professions (mechanical engineering, space technology, microbiology and game development); five were based in Saudi Arabia and three in the USA (Appendix A.1).

Mentees were grouped to create a sense of community, to maximise the benefits of information shared collectively by mentors and mentees, and to show the mentees that other girls their age were interested in STEM and faced the same challenges (Stoeger et al., 2013). The choice of groups was also derived from the lack of understanding of the mentoring (e-mentoring) concept, so grouping was intended to encourage participation and help

participants learn and understand how others interact. Group e-mentoring facilitates learning from peers' mentoring experience (O'Neill, 2004). While group e-mentoring was the main structure of this study, Edmodo also provides the feature of one-to-one messaging between a mentor and a mentee, which enabled one-to-one e-mentoring.

4.2.4 *Study design*

Mentors and mentees communicated through the Edmodo platform. For each mentor, I created an individual group, gave the mentor the Group Code and assigned her as a co-owner of the group. I sent each mentee her mentor's Group Code to access their group via email. Mentees shared their thoughts and ideas with their mentor. Mentors and mentees could post to the group, comment on other posts and 'like' posts. All discussions were supervised by me and the mentor in that group. PCGs could sign up and use the unique Parent Code obtained from their daughter's Edmodo account. I monitored all activities between mentors and their mentees. Mentors and mentees were made aware that I and their PCGs had access to all their private messages. The text-based messages were in Arabic and/or English.

It was important to manage expectations by identifying the goal and purpose of the program, and the expected contact frequency (Bierema and Merriam, 2002; Single and Muller, 2005) to increase the likeliness of success. Participants were informed that the study would last for two months and that the minimum expectation of engagement was one hour per week through Edmodo. The goal of the program was to advocate STEM, connect young females to STEM female professionals and help mentees find answers to their questions about a future in a STEM career in Saudi Arabia. The role of the mentor was to share personal experiences, to ask questions and engage in conversations to build their relationship with the mentee, and to guide discussions.

Training and coaching are two aspects of the planning phase (Single and Muller, 2001). Due to the small scale of this study and to keep materials on hand for the mentors in their personal emails (Single and Muller, 2001), I used email as a method of training. Prior to the study, instructions on how to use Edmodo were sent to both mentors and mentees. Resources gathered from the web about e-mentoring and building mentoring relationships with mentees were sent to mentors through email. Weekly emails were sent to mentors, with some sent as reminders to engage with their mentees. Others were informational descriptions of mentoring or topic suggestions to prompt discussion with their mentees. Reminder emails were also sent to mentees. Some mentors were worried about their mentees not responding and they contacted me to get in touch with the mentee. Use of these kinds of email has been previously established as an effective coaching mechanism to increase engagement (Single

and Muller, 2005) and has been suggested as a way to reduce dropout (Lee and Noh, 2003; Stoeger et al., 2013).

4.2.5 *Data collection*

Single and Muller (2001) in their work on the model of structured e-mentoring recommended collecting three types of data: involvement data, formative data and summative data. Involvement data is concerned with the nature and frequency of mentors' and mentees' interactions in the e-mentoring program. In mentoring programs, the frequency of face-to-face interactions is considered a measurement of success; therefore, according to Single and Muller (2001), the frequency of email exchanges is an indicator of success in e-mentoring programs. Involvement data looks into the interaction between mentors and mentees by examining their relationship, frequency and engagement, and is considered an important indicator of success (Bierema and Merriam, 2002; Single and Muller, 2001). Formative data relates to the process of mentoring and helps with the modification and improvement of the program – it is the data that helps improve future iterations of the program. Program administrators collect formative data from participants' evaluations of the program and identify which elements of the program were beneficial. The data collected helps in reducing barriers and problems faced in this iteration of the program and also in recognising its points of strength. The final type of data is summative data, which addresses the effectiveness and outcomes of the program by evaluating the achievement of the program's goals and the value. Each program focuses on one or more goals, such as increasing mentees' knowledge, attitudes or behaviours within a certain context.

Involvement data in this study was collected from posts written by participants. Formative data was collected from nine individual interviews with mentors (n = 3), mentees (n = 3) and parents (n = 3), and a focus group with six mentees. Summative data was collected from pre/post-study surveys and mentor and mentee interviews. Interviews and the focus group were recorded and transcribed. Arabic data was translated into English and is marked with an asterisk.

4.3   Results and Analysis

4.3.1 *Pre-study survey*

A pre-study online survey was completed by the mentees and their parents, and it was in two parts: 1) demographic data; and 2) mentoring experience and expectations. The demographic data, such as parental age, education level and profession, was completed by the PCGs. The second part was about the mentees' experiences and expectations of mentoring and e-

mentoring (Appendix A.2).

Out of 22 mentees, 10 answered the pre-study survey. The results, shown in Table 4-1 below, show that four of the parents (two mothers and two fathers) were illiterate and four other parents (two mothers and two fathers) had only primary school education. Two fathers worked in STEM fields (engineering and computer science); however, none of the mothers did. Seven mentees knew adults who worked in STEM fields and five mentees knew females who worked in STEM fields. No participants or their family members had ever participated in a mentoring or e-mentoring program of any form. Participants joined the program to "engage in a new experience"* and "to gain more knowledge in subjects I'm interested in and make more decisive choices on my college major"*. One girl emphasised the lack of family members who could guide her: "My family do not have a scientific background, and I have big dreams and I need those who guide me"*. Four mentees joined the program via social media announcements, three mentees joined the program from a friend's recommendation and one mentee joined from my school visit. Two mentees specified that they knew about the program from other sources; one knew about it from her teacher and the other from her older sister.

Table 4-1 Parents' demographics

		Fathers	Mothers
Age			
	30–45	1	3
	46–60	5	7
	61 or older	4	0
	Deceased	–	–
Level of education			
	Illiterate	2	2
	High school	2	2
	Bachelor's degree	6	2
	Master's degree	–	2
	Doctoral degree	–	2
Major			
	Science	–	–
	Technology	1	–
	Engineering	1	–
	Math	–	–
	Other	8	10

4.3.2 Level of engagement

While participants were asked to spend a minimum of one hour per week interacting in their groups, which would be equivalent to at least one interaction per week (8 interactions per

participant for 8 weeks), the results showed significantly lower levels of participation than this, even for the most active participants. The numbers of posts, replies and likes were used as an indicator of the level of engagement of the mentors and the mentees (Adams and Hemingway, 2014). In their study, Adams and Hemingway (2014) characterised their mentors based on the average number of comments, with a total of 1086 comments written by 170 mentors with an average of 6 comments per mentor. As a result, they characterised mentors with 1–3 comments as "low", mentors with 4–7 comments as "medium" and mentors with more than 8 comments as "high". In this study, I followed Adam and Hemingway's (2014) approach to characterising participants. The total number of posts and likes was 121 (110 posts and 11 likes). While 8 was the expected number of interactions, 4 was the average figure recorded over the 8 weeks. Therefore *Low (L)* engagement was assigned to participants with between 1 and 4 interactions, *Medium (M)* for 5 to 8 interactions and *High (H)* for 9 interactions and above (13 was the highest number of interactions recorded).

Table 4-2 summarises the numbers of posts, replies and likes for all groups. To identify the mentors, I refer to them by their group identifier and activity level. For example, the mentor of group A, with a medium activity level, is identified as A_M. Mentees are identified by their activity level and their mentor's identifier. For example, mentee B in group A, with a low activity level, is identified as $B_L A_M$. Mentees who signed up and joined the group but did not participate are described as passive participants (P) and mentees who chose a mentor but did not join the group are described as not registered (NR). Owing to the limitation of not having access to log files, I was not able to determine whether passive mentees had followed discussions (but not contributed) or were completely disengaged.

Table 4-2 Numbers of posts and likes of members in all groups

	Posts	Replies	Likes	Total		Posts	Replies	Likes	Total
Group A					Group E				
A_M	1	6	0	7	E_H	6	5	0	11
A_LA_M	0	2	0	2	A_LE_H	0	2	2	4
B_LA_M	0	2	0	2	B_LE_H	0	2	2	4
C_LA_M	0	2	0	2	C_PE_H	0	0	0	0
D_PA_M	0	0	0	0	Group F				
E_PA_M	0	0	0	0	F_L	2	0	0	2
Group B					A_LF_L	1	0	0	1
B_M	1	5	1	7	B_PF_L	0	0	0	0
A_MB_M	0	5	0	5	Group G				
$B_{NR}B_M$	N/R	N/R	N/R	N/R	G_H	4	9	0	13
Group C					A_HG_H	0	6	2	8
C_H	8	2	0	10	B_LG_H	0	2	1	3
A_MC_H	0	5	0	5	C_MG_H	0	4	1	5
B_LC_H	0	3	1	4	Group H				
Group D					H_H	4	5	0	9
D_L	2	1	0	3	A_LH_M	0	3	0	3
A_LD_L	0	2	1	3	B_LH_M	1	0	0	1
B_PD_L	0	0	0	0	C_LH_M	0	4	0	4

While participants were asked to spend a minimum of one hour per week interacting in their groups, the results showed significantly lower levels of participation than this, even for the most active participants. Group A had the largest number of mentees, but their activity level was low or passive (Figure 4-4). Mentor A_M in her last reply said: "I'm busy at this period of time, I will be back soon to answer your questions"*.
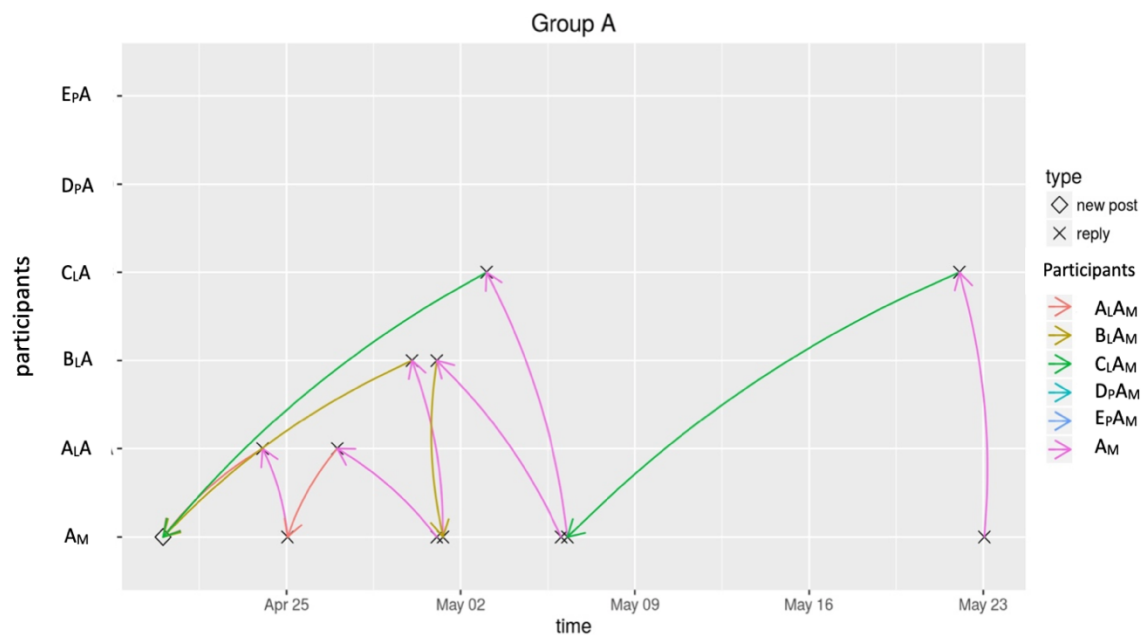
Figure 4-4 Group A had the largest number of mentees, but their activity level was low or passive.

Even the participants identified as H participants had lower levels than expected. H participants in some groups did not necessarily have many interactions with members of the group. Mentors E_H and C_H (Figure 4-5) had more than once posted more than one new post in a single day, which increased their level of participation to H, but some of these posts did not receive any response from the mentees in the group. The first month of the study witnessed most of the interactions. At that initial stage, the mentors were introducing themselves and the mentees were curious to know more.
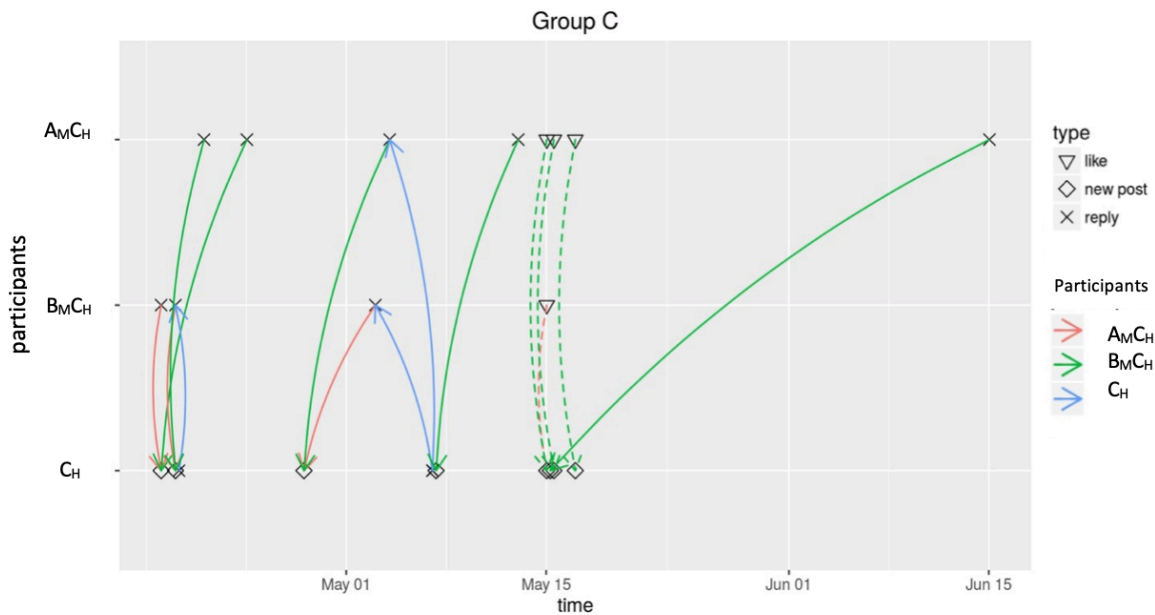
Figure 4-5 Group C shows a high-activity mentor who wrote more than one new post in a single day, even though some of these posts did not receive any response from the mentees in the group.

Later, all the groups had gone inactive except for group G, which was engaged in discussions about the video game they were designing. Mentees did not respond or address each other, although all posts and replies were public within each group. All communications were between a mentor and a mentee. In group F, three new posts were written but without any interaction between their members. Mentee A_LF_L initiated the first post in her group: "Hello. When can we begin the discussion about architecture and pursuing it as a major and career?". She did not get any response. After two days, the mentor of that group Mentor F_L wrote a new introductory post, disregarding the first post by Mentee A_LF_L (Figure 4-6).
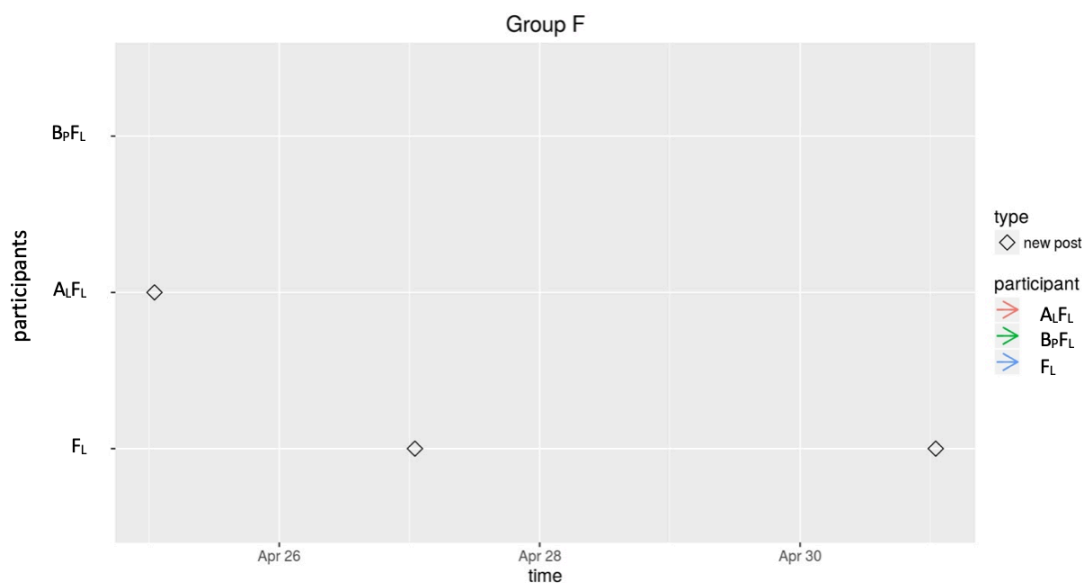
Figure 4-6 Group F shows no interaction between participants. Mentee A_LF_L initiated the first post in her group, but mentor F_L disregarded her post.

In group B, regular posts were exchanged between Mentor B_M and Mentee A_MB_M. When the mentee did not respond to the mentor within ten days, the mentor wrote another post. Then Mentor B_M sent an email to me asking about her mentee: "I wonder if there is a way to check on my mentee. I don't know if she still receives my messages or I somehow lost her." I contacted the mentee and informed her that her mentor was concerned about her. She replied to her mentor and apologised, saying she had not received notifications about the posts.

4.3.3   *Analysis of posts*

Thematic analysis (Braun and Clarke, 2006) was applied to the qualitative data: posts, and interviews (mentees, mentors and parents). I applied the inductive approach to thematic analysis (Braun and Clarke, 2006), a bottom-up method where data coding is conducted regardless of researchers' assumptions. It is considered a data-driven methodology because themes originate from the content of the data. I studied the data, generated themes and validated them with my supervisory team. A total of 110 posts were coded and there was significant variation in the content. I briefly describe the themes extracted from the posts to give an overview of the topics discussed. Three themes were identified within conversations: 1) request; 2) inform; and 3) engage & motivate.

Request

Different types of requests were noted by mentors and mentees. The majority of requests were

informational requests about study and careers from the mentees:

> But I do not know exactly what it is like to study in universities and what possible jobs I could get if a choose physics as a major? This also applies to mechanical engineering* – Mentee $A_L A_M$

Mentees also requested resources in the form of books, websites or applications. One mentee asked her mentor a networking request. She asked her mentor to connect her with researchers at the centre she worked at:

> I'm interested in working at … so I thought this is the ideal place if I want to get involved in research … I want to ask you if you know any researchers working in biotechnology if you could link me to them directly. – Mentee $C_M H_M$

On the other hand, mentors had different types of requests; they requested background information about their mentees. They asked their mentees to talk about their future plans. Mentors also requested feedback on previous suggestions:

> Who you are … talk about yourself? How do you see yourself in 3 to 7 years from now? – Mentor A_M

Inform

Mentors provided information about their studies and careers. They also explained the differences between study majors within a field (e.g. between studying electrical and mechanical engineering). Mentors discussed their job responsibilities and research areas. Mentor H_H talked about being among the first group of females working on space technology and the difficulties she faced:

> It is a new field for all of us. We were the first group of females who worked in this field. Beginnings are always special. We needed to learn a lot to be able to continue with our work. We had online courses. Every now and then we decide on a course book and we study it together.* – Mentor H_H

Mentors provided their groups with suggestions and resources with or without a request from their mentees. Mentees gave feedback about suggestions or resources made by their mentors:

> Thank you for the reply :) I might delve into the history of mathematics, and might as well take a few physics online courses because I think I need more practice in that subject. – Mentee $B_L A_M$

On several occasions, it was noted that mentors were justifying their absence and not responding very often:

I apologise for not replying sooner, but from now on I'll be posting every weekend.* – Mentor G_H

Engage & motivate

Mentors used a range of approaches to engage mentees, including asking mentees both personal and general questions, and encouraging mentees to research their answers and discuss the questions within their group. They aimed to give the mentees a chance to look up answers and discuss them within their group:

> Have you heard about a lost satellite? How does a satellite get lost? What do you think they mean by lost?* – Mentor H_H

Some mentors tried to establish common interests and personal connections. Mentee A_MB_M mentioned that cooking was one of her hobbies and her Mentor B_M told her that they shared the same hobby and that she planned to cook two new recipes every month. Mentors shared personal pictures of their labs or workplaces as a way to engage the girls and make a personal connection. Tasks and projects were another way mentors attempted to gain engagement. Mentor G_H started a small project with her mentees to design a video game. The girls got excited and discussed the characters and story of the video game:

> Mentor G_H: Let's start developing a horror game. Before developing, we need to design it. Without a design and plan, the project could take more time than expected and cost more. There is no one right way to design a game. It differs from one studio to another … Let's start by choosing the world, characters, plot and way to play.*

> Mentee A_HG_H: It would be nice to use space as the world for the game, Mars for example, since we have more information about it. The main character is a human. The story, for example an astronaut who is lost in space and trying to survive. We can add scary things like black holes, aliens or starbursts.*

It was noted that some mentors motivated the girls by addressing them as "future engineers" or "future scientists" and encouraging them to pursue their dreams. Mentor C_H shared a link that listed the top 20 engineering universities in the USA and described how she had been accepted in one of them after applying three times. In six groups, mentors communicated using an informal language and style with their mentees. Mentees and mentors used emoticons, such as smiley faces, flowers and hearts. Two other mentors had a different style of writing and the mentees in these groups were identified as low or passive. Mentor E_H, who is a lecturer at a public university, addressed her mentees as "students" and the group as a "study group" and she asked if they had understood the "lesson". Mentor F_L wrote two posts using a letter format:

> Dear Young Ladies,

I hope this finds you well.

First, let me introduce myself …

Hope to hear from you soon!

4.3.4 *Interviews with mentors and mentees*

For the post-study interviews, I selected participants who exhibited different levels of participation: one mentor with medium activity levels and two mentors with high activity levels, and one mentee with high activity levels and two mentees with medium activity levels. Mentees and mentors with low activity levels did not respond to my requests for interviews. The semi-structured interviews were conducted by phone. Interview questions concerned the respondents' participation in the e-mentoring program in general and also focused on the barriers and benefits.

As the interviews were semi-structured, I combined deductive and inductive techniques of thematic analysis (Braun and Clarke, 2006). In contrast to the inductive approach, the deductive approach is top-down and is driven by the researcher's interests. The combination of inductive and deductive approaches resulted in data-driven and interview-driven themes. Some of the interview questions are listed below:

- What expectations did you have about the e-mentoring system?
- Why did you join the program?
- Why did you choose your mentor?
- What barriers or problems did you face during your participation?
- Did you share your experience or what you have learned with others?
- Would you join an e-mentoring program again?

The main themes that emerged were misunderstanding of e-mentoring, awareness of the low level of interaction, communication method as a barrier and benefits of e-mentoring.

Misunderstanding of e-mentoring

Two of the mentees had different expectations about e-mentoring. Mentee $A_H G_H$ thought that the goal of the e-mentoring program was to introduce them to university majors, which was "what everyone is doing" and she thought the idea was "cliché". Mentee $A_M C_H$ expressed that her expectations had been lower than what she experienced in the program. Her assumption was that it would be a Q&A session, but it turned out to be "something better". On the other hand, Mentee $A_M B_M$ thought that the program was as she expected it to be.

Mentor B$_M$ and Mentor C$_H$ expected to be guiding the mentees on a specific project with certain tasks and that they would be "the facilitator that will help them through some sort of electronic communication platform". Mentor H$_H$ loved the idea of mentoring, but she was not prepared. She explained: "I started to ask people from work about interesting topics to share with those girls."

Awareness of the low level of interaction

Of the mentors and mentees who were interviewed, all agreed that they had expected more interaction. Mentors expected the girls to have more questions and requests, while mentees assumed mentors would actively initiate discussions and activities. Some said that having more mentees in a group might increase overall engagement. However, despite all communications between a mentor and a mentee being visible to all members of a group, mentees did not interact with each other. Mentors described their attempts to engage their mentees, but suggested that the mentees' low levels of engagement might also be due to girls of this age having reservations about being able to express themselves clearly:

> I tried to use different methods and topics and see which way would attract the girls the most. – Mentor H$_H$

As mentioned earlier, there was no interaction between mentees. The following comments extracted from mentees' interviews exemplify their thoughts about interacting with their group members:

> I think we should get to know each other but I don't know how … like an introduction post about the girls. – Mentee A$_H$G$_H$

> None of the other mentees wrote something that we could respond to or discuss with each other.* – Mentee A$_M$C$_H$

Communication method as a barrier

Both mentors and mentees agreed on the difficulty they experienced using text as the only means of interacting with each other and reported finding it challenging to express themselves as a result. They raised a number of issues with the asynchronous text communication of Edmodo, including the long response times, the time required to write posts and the mentees' struggles to express themselves:

> I didn't like the long response time.* – Mentee A$_M$C$_H$

Mentor C$_H$ on different occasions mentioned that using text was a barrier for her and her mentees: "Interaction using text is very slow … Using text was an obstacle for me." She also commented about how using text could have affected the level of participation of the

girls. She thought that using text from the girls' point of view would mean leaving a "trail" or a "mark". Mentor B_M talked about her situation being based in the USA and how the time difference that accompanied asynchronous communication was a problem:

> The biggest limitation to me was the time difference. There is more than 10-hour difference than time in Saudi. I couldn't reply to her at the same moment she wrote to me. If she sent me something at 12 pm Saudi time, I could be going to bed and I might answer her after 7 hours. There is this big disconnect. Through this disconnect maybe she sent me something she was excited about and then she went on with her day and whatever she wanted to know or she was excited about might disappear. – Mentor B_M

She also mentioned that using the written platform to communicate required time to actually sit down and think about something to write after a very long day of work. Mentors and mentees found it challenging to express themselves or to understand others:

> It takes a long time to explain our points to each other.* – Mentee $A_M C_H$

> It would help me to know her way of expressing herself, I could know her demeanour, is she a shy person for example. We can connect in a different way. This is what I really wanted. I don't think that text would provide that missing part, but I thought that it would be really good if we were talking instead of writing … There are lots or things missing and usually, you need to write less to write faster. – Mentor B_M

It was evident from interviews that participants wanted another method of communication to build a stronger relationship. Suggestions were to use audio or video channels for communicating:

> It will be more exciting if it was a video call especially with a group of girls, we could brainstorm and exchange ideas … Teenagers will be more excited if it was a video call meeting and we could know each other faster.* – Mentee $A_H G_H$

> As a main way of communication, it should be something that we can talk in like Hangout or Skype … There are verbal and nonverbal cues that you could get from an audio/video communication, you can know if she is thinking and you help her think or is she shy and silent. She can learn from me the way I talk and discuss things. Mutual benefits. – Mentor B_M

When I asked Mentor B_M if she had any concerns regarding scheduling an audio/video call with the time difference situation, she said that if there is a will, there is a way. She stated that sessions could happen during work breaks or early in the morning before going to work. On the other hand, Mentee $A_M B_M$ thought that the main problem was using a platform that nobody used and suggested platforms that were more popular. She explained: "Using a social communication network that was faster and easier to use, and everyone is using it already, so I won't forget to log in and check Edmodo."*

Benefits of e-mentoring

Another theme that emerged from the analysis of the interviews with mentors and mentees was the benefits of e-mentoring; since this is related to the outcome of the program, it is considered summative data. Although the levels of interaction were lower than anticipated, mentees showed a considerable increase in awareness of STEM careers and opportunities for females in Saudi Arabia. Girls were impressed by the achievements, studies and careers of their mentors. Prior to the study, two mentees reported not being aware that such careers existed for Saudi females. The study also had a positive impact on some girls who had decided to study a STEM major beforehand. One mentee, who liked to play video games, said that she had considered studying computer science but did not have a detailed understanding of the subject. However, thanks to her interactions with her mentor, she realised that game development was a career option for a computer science major. Another girl was relieved to know such a career existed for Saudi females:

> Before joining the program, I was upset because I did not know that such career and jobs were available for females in Saudi and I thought that if I pursued this kind of study I would have to get a job abroad which is impractical and unlikely to happen. When I knew about the opportunities for females regarding science & technology, I was relieved, and I know now that I can pursue my dreams.* – Mentee $A_M C_H$

Some mentees showed how they shared the knowledge they gained from or about their mentors. One mentee shared a picture of robotics with her school team. They were in a robotics competition. The picture was posted by her mentor, showing a robot designed in the lab she was working in. Other mentees found mentors' career so interesting that they talked about them with their parents and friends. Mentors were encouraging and motivating by giving them examples of what they had accomplished:

> One of the girls was interested in robotics when I saw this post on Facebook I remembered her and I wanted to share with her this post about top universities. I'm in one of these universities so I wanted also to show them that as a Saudi female you can achieve and get into any school you want if you have put your mind into it. I got into [university name] which is one of the top universities in its field after applying 3 times and got accepted the third time. – Mentor C_H

Mentor B_M and Mentor H_H shared their experiences with their colleagues at work. Mentor H_H said: "When I talked to people at my work about the program, they were surprised that there are girls interested in their future at this young age."* Mentor C_H and Mentor B_M talked about a different kind of sharing; they talked about sharing the e-mentoring experience with a wider audience:

There is a part of the whole experience that can be shared with other participants. Sharing impressions, tips. – Mentor B$_M$

During the duration of the program I attended a conference and I wanted to share my experience with the others. If there was something like a twitter account, we follow and it could share or retweet my experience that would be nice. Or maybe a hashtag that we all use to post about our experience with e-mentoring. It will bring attention to e-mentoring. – Mentor C$_H$

Mentor B$_M$ shared her previous experience with school students. She previously worked at an interactive science centre in Riyadh, designing science shows and programs for school students. From her experience, she found out that young Saudis had a conception that accomplishments and successes in STEM cannot be achieved in Saudi Arabia or by Saudis. To raise their awareness and hopes, she added male and female Saudi scientist to the shows, but the students felt that those people were exceptions and what they had done was extraordinary and unusual:

It is important in our society … There are a lot of things happening that are not shared in our own culture, and if it is shared it will be shared in a context that these people are outliers, or this thing happened out of the extraordinary. And it's not, it's more common than we think. – Mentor B$_M$

Mentor H$_H$ described her mentee asking for an internship opportunity at her workplace; she said: "it felt like networking." Even though the concept of mentoring is not common in Saudi Arabia, mentors agreed on the importance and empowering potential of mentoring. None of the mentors reported having been in a mentoring relationship before, as either a mentee or a mentor. They explained their personal motivation to mentor in relation to their desire to, or need to, have been mentored themselves earlier in their careers. Mentors believed that their lives and professional experiences should not be limited to themselves and that they should give back and share these with younger generations to give them hope and encouragement. The concept of mentoring was seen to be important and empowering, especially in Saudi Arabia:

We were a generation that needed support and we wanted to communicate with experts to guide us, especially when no one in your family or people around you have the same interest.* – Mentor H$_H$

It's empowering in so many ways, it has guidance and your experience is not limited to yourself it's part of giving back … Having this platform that we can actually share the experience that led us to be where we are now with someone younger or someone at a crossroads. That would be very very rewarding at so many levels and at the same time empowering not only to me as a mentor but to the mentee it will leave an impression and I think that this is really important. – Mentor B$_M$

4.3.5 *Interviews with parents*

I sent requests for semi-structured interviews to all parents of mentees and three mothers agreed to participate. Mother#1's age range was 45–60 and Mother#2's and Mother#3's age range was 30–45. Mother#1 was an assistant professor in the College of Arts, Department of Arabic Language, Mother#2 was an English teacher and held a bachelor's degree in Languages and Translation (English) and Mother#3 held a bachelor's degree in Special Education and worked in the Ministry of Education.

Despite the platform's configuration, none of the parents actively participated in the program; therefore, it was essential to understand the reasons for this. I was keen to understand parents' views, opinions and reservations about the idea of e-mentoring. The themes that emerged from the mixed (inductive and deductive) thematic analysis of the parent interviews were appreciation and need for mentoring, own struggle and experience, concerns and mentoring and society. Some of the questions that were asked included:

- Have you ever been mentored? By whom?
- What do you think mentoring is?
- What do you think the benefits of mentoring are to your daughter?
- If your daughter asked you to join an e-mentoring program that uses video or audio communications, would you agree? Why or why not?

Appreciation and need for mentoring

All three mothers were appreciative of the program and stressed the need for and importance of it. Mother#1 informed me that she had attempted on her own to educate students at her daughter's school (which was a government school) about her major, but the school had told her that the Ministry of Education had refused the idea of having an external individual talking to the students. She also told me that she had been the one who told her daughter about this program, as she saw it as a good opportunity:

> I really admire the effort you put into the mentoring program and I liked the pilot study that my daughter joined, she really benefited from it. It is something that serves the whole society, we have a lack of awareness about careers and studies. You can turn it into something big later on, like a social institution and others can sponsor it.* – Mother#1

The other mothers also expressed their appreciation and the need for mentoring:

> I wish I had had someone to guide me or answer my questions. In my day the choices were limited, you became either a teacher or a doctor.* – Mother#2

> If there is a chance that my daughter can meet some professional woman who is working is such a field, that would be a wonderful opportunity!* – Mother#3

Mother#2 talked about her younger daughter (12 years old), who was fascinated with space and astronomy, but they were concerned because they did not know about any female Saudi professionals in this field. They came to a decision: "The last thing she decided is that in the next two years, if she couldn't find a Saudi woman working in this field, she will study law and become a lawyer. There is no awareness in schools or any other place about women and their careers in Saudi"*.

Own struggle and experience

Through the interviews, the mothers shared their stories of the challenges they faced when their daughters were applying to universities and how they overcame these struggles. They also described the significant effort their daughters put into finding answers to their questions about course options.

> Mother#2 explained: "I wish there were programs or events that introduce the girls to universities and careers … I struggled personally with my daughter. I took days off from my work to take my daughter around universities in Riyadh. We wanted to know more about the opportunities available"*. She continued talking about their visits to universities, which were not as beneficial as they had expected. Later on, her daughter had attempted to make a detailed comparison between three majors she wanted to study using all the resources she could find, including websites, the university-provided course information and even by contacting current students who were studying these majors:

> Luckily my daughter found a girl who is older than her and used to study at the same school. She got in touch and started asking more questions about the major and the university.* – Mother#2

Mother#3 told me that they had lived for a couple of years in the UK and recently come back to Saudi Arabia. She elaborated: "They asked the students to write a plan for their future and how they would imagine it. When we came back, my eldest became frustrated because what she dreamt of might not be applicable for a girl in Saudi"*. She explained that her daughter had "no clue" about how to find out more or who to ask about the field that she wanted to study, so she (her daughter) attempted to contact girls and women who were studying and working in the field and asked them about the things that concerned her.

Concerns

Two mothers (Mother#1 and Mother#2) had some concerns about the mentors' political,

religious and social views causing conflict between the mentee and her family, and the mode of communication. Regarding political and religious views, the mothers felt that these topics should not be discussed. Mother#2 showed concern that the mentor might take advantage of the young girls: "She [the mentor] might also tend to have political or religious views that are against our beliefs. It worries me a mentor might take advantage of this channel and use it to convince these young minds with their thoughts. If there are censoring and supervision of these calls, I might feel more comfortable"*.

Another concern of Mother#1 and Mother#2 was that they worried that the mentor would encourage the mentees to disobey or create conflict with their families. Even though she knew that her daughter would not be easily convinced by anyone, Mother#1 was worried that some girls might be. She talked about her relative's daughter, who was encouraged by her teacher (who was supposed to be a role model) to disobey her parents and the mother eventually had to transfer her daughter to another school:

> A relative of mine has a very smart and gifted daughter, she always gets As in school … That teacher supposed to be a mentor was forcing and convincing the girls to choose majors such as marketing and she told them to disobey and disagree with their parents if they advised them to choose majors like science or computer science. The mother did not like the way she [the teacher] was convincing the students and that she created a conflict that did not exist between the parents and their daughter.*

Mother#1 explained that the parents did not have a problem with any major their daughter wanted, but with the negative way that the teacher was encouraging them which created a conflict between the student and her parents. Mother#2 emphasised the importance of mentors not interfering in family decisions. She explained:

> She should not interfere in family matters either. For example, if the girl wanted to study a major that is not available in Saudi universities and she has to study abroad but her parents are against the idea, the mentor should not encourage the girl to insist and rebel against her family, which might create problems between the girl and her family. If she tried to convince the girl peacefully and give her arguments that she could discuss with her parents or the mentor suggested that she talk to the parents and explain her point of view, I think that is fine.*

She also suggested that mentees should have the choice of changing their mentor: "It is also important that the girl can decide if she wants to continue with the same mentor or not"*.

Mother#3 did not share the same concerns and explained that every opposite opinion to theirs is available on the internet. She explained:

To be honest with you, the world has changed. The girls are part of the open world now; we cannot control what they see or read or know anymore. The internet has opened everything for them. I don't have issues with trust because I believe I raised my kids well enough to know that if there is something wrong, they will talk to me about it and I don't think the mentors would raise a topic that is not already there on the web.*

With respect to mode of communication, the three mothers did not encourage the use of video channels but accepted that their daughters were using these to communicate with their friends, and ultimately agreed that these were acceptable where the purpose would be beneficial for them. Mother#1 explained that the differences between generations meant she did not seek to exercise excessive control over her daughters' behaviours as she knew that they could do whatever they want behind her back:

In my opinion, I wouldn't encourage it, but I know that they use it. I would prefer audio conversations between them. You know, the differences between generations make me not strict in controlling my daughters because I know that they can do whatever they want behind my back. I would prefer to allow them and be in the picture.*

All the mothers did not feel the need to actively participate in the program themselves and explained this in various ways: they wanted their daughters to talk freely, they trusted their daughters and they believed that their daughters lived in an open world now where everything was available to them and they cannot control what they watched or read or who they talked to. Even though they did not participate, knowing that they could participate was important to them. Parents' participation might occur in cases where they were not convinced that what their daughter was learning was appropriate or where they wanted to participate in discussions on certain topics.

Mentoring and society

From the three mothers' point of view, the importance of mentoring meant that the benefits to society were greater than the benefits to the individuals. It would enhance their sense of belonging to society and awareness of others in the same position and of opportunities. It was a chance to network among others who shared their interests:

It is something that serves the whole society.* – Mother#1

Mentoring would give them safety and confidence that they are not alone in this, career options or other opportunities. To get introduced and network with females in their field. Mentoring is voluntary, which would make the girls appreciate their mentors and their society because they would feel cared about and that society is supporting them.* – Mother#2

I want the mentor to make the girls believe in themselves and their society.*
– Mother#3

4.3.6 *Focus group*

Six mentees who exhibited different levels of engagement joined an online focus group to talk about their views, participation in the program and how the experience could be improved. At the beginning of the session, I asked the participants about their understanding of mentoring and their fears towards their future career wise, and then the participants shifted the discussion towards e-mentoring without guidance from my side. The participants felt more comfortable conducting the focus group in Arabic. The session was recorded, transcribed and translated.

Regarding their understanding of what a mentor was, one mentee said that she honestly did not understand what a mentor was, while two mentees described a mentor as an experienced person who guided you through a new phase:

> A mentor helps you when you go into a field that you know nothing about or you have questions about something career wise, then they could guide you to the best way for you.* – Mentee B_LA_M

> When you start something new, they are other people who went through similar experiences who you can learn from. – Mentee A_HG_H

Five of the participants shared fear of the unknown about their major and career. Because they did not have enough knowledge and information about majors and work opportunities, they worried that they would make the wrong decision and regret it:

> I worry that when I finish my studies and have a career, I will not be satisfied with my job.* – Mentee C_LA_M

> I really fear that I might study a field that I will not like and I would feel that this is not what I want to do in life. I worry that I might regret choosing a major or career that will not fit me.* – Mentee A_HG_H

While one mentee was not worried, she believed that if she felt that she had chosen a major that she did not like, she could gain a master's degree in another field. Mentee A_HG_H responded to this thought:

> I think choosing a bachelor's degree is very important even if you choose to complete your master's in another field. A bachelor's degree gives you knowledge and information to build on and it would help you in your master's even if you chose something relatively different to your first major.*

They were worried, but they talked about their own process of seeking information about a certain field or career (e.g. talking to people, visiting labs and reading about the field):

I talked to undergraduates who are in the field that I want to study. I asked them about the positives and negatives of the field. The most important question that I asked was who the perfect candidate is to study this field. From their answers, I could decide if it applied to me or not. I visited labs, universities and hospitals to know the environment of my future career.* – Mentee B_{LA_M}

I asked a lot of people around me in different fields, even in fields that I'm not interested in. The most important question that I asked was what the negatives of your career or field are, to see if these negatives will affect me or I will be fine with them. I also read about fields online. I might know what I'm not interested in, but I don't know what I want.* – Mentee $A_M C_H$

Three of the participants described the challenges they faced in finding professionals to talk to, especially women, and the difficulties they experienced in identifying the right questions to ask professionals who they would have no chance of meeting again:

Every person has their own experience, no two people will have the same experience. I either talk to people who graduated a long time ago or are still studying. I fear that if I choose a field, it will be different from theirs. Most of the people I talked to were male, not female. If I found a female and I could talk to her, I could relate to her more than if I ask a male about his experience.* – Mentee C_{LA_M}

I think that talking to people would not help me in choosing my major, but I believe it would help me in learning about their life experiences, their networks or connecting me with other people.* – Mentee $A_M B_M$

After that, the discussion moved to their e-mentoring experiences and they discussed how they had wanted it to be. All six mentees demonstrated a preference for not being required to have an exclusive relationship with one mentor, but rather having the freedom to choose who to talk to and for how long:

I think it would be much better to have and know more mentors. I'm clueless about all the fields and opportunities around me. That's why I would like to learn more from the mentors. Even if I'm not choosing her field as my major, I would be interested in knowing more about different fields and I might talk more than once with more than one mentor.* – Mentee $C_M G_H$

Mentee $A_M B_M$ suggested adding some personal information about the mentor in addition to her career and professional profile; she explained: "Not just about her career, but also something personal. It would help me choose"*. Mentee $C_M G_H$ showed her support of the idea of adding personal information about the mentor: "I liked what she said about adding personal information to the mentor's profile"*.

The mentees indicated that before committing to the mentor–mentee relationship, they would prefer to schedule a short (virtual) meeting with the mentor. Such a short meeting would help them decide whether they wanted to commit to a longer term relationship:

> I could talk to more than one mentor for 15 or 30 minutes and then I would pick the one who I felt would help me the most and continue my sessions with her.* – Mentee $A_M B_M$

> If I found one mentor who I wanted to build a mentorship relationship with, we could communicate with text, for example if I have a quick question, rather than scheduling a meeting. – Mentee $C_M G_H$

Participants' views differed on the nature of the e-mentoring session. Four mentees preferred being in group e-mentoring with a limited number of mentees (maximum 4 mentees); they explained that other participants might discuss or ask questions that they had not thought of. One mentee suggested that a one-to-one session could be scheduled afterwards when she chose to be committed to a specific mentor:

> Sometimes people ask questions that never occurred to you, but the answer could really be helpful to you. Exchange of knowledge! I would suggest limiting the number of participants to 3 or 4 girls in group sessions to reduce interruptions.* – Mentee $C_M G_H$

> I might start with group sessions and when I choose a specific mentor, then I would prefer one-to-one sessions. – Mentee $A_M C_H$

One mentee disagreed and preferred to have a one-to-one session with her mentor, but she did not mind joining a group session. She explained:

> Group mentoring could be helpful sometimes if I didn't know what I want. Usually when I choose to talk to someone, it means I know what I want to ask, and I would like it to be private.* – Mentee $A_M B_M$

One mentee was neutral between one-to-one or group sessions. She said that her choice would depend on her purposes with e-mentoring. If she was just exploring, then she preferred group mentoring, while if she had a specific domain, then she preferred one-to-one:

> It depends if my questions are very general and I would like to explore the field, then I don't mind having a group session with others. But if I'm in depth with my questions and I need specific answers to my questions, I'd rather have a one-to-one session to get direct and clear answers without interruptions from others.* – Mentee $B_L A_M$

The issue of the seriousness of the program was also raised and they expressed a concern that some girls might waste the mentor's time or not show up. To this end, they suggested the application of a charge for not showing up, banning non-attendees from scheduling further meetings for a period of time or rating mentees by mentors so other mentors had the option to not accept meeting requests from a low-rated mentee:

> I would recommend a fee to so the girls will know it is something serious and won't waste the mentors' time.* – Mentee $A_M B_M$

Sessions could be for free but if you missed a session without excuse, you should pay for it and the money would go for a good cause.* – Mentee B$_L$A$_M$

At the end of the session, the participants discussed the importance of mentoring and the ways to attract girls who were not interested in participating:

The idea of mentoring should be explained in a clear way for girls to understand its value. When I joined the mentoring program earlier, I didn't understand what it was exactly, but I joined because I wanted to learn about it, and I found it a very interesting experience and useful and not what I imagined.* – Mentee A$_H$G$_H$

I would really like to know about all the fields available and opportunities. A wider knowledge. I don't want to miss good opportunities just because I didn't know about them.* – Mentee A$_M$B$_M$

There was an argument between three participants on whether or not e-mentoring could change girls' views and make them more interested and concerned about their future:

Mentee A$_M$B$_M$: I don't think that a 30-minute talk with a mentor would change the perspective of a girl who is not interested in thinking about her future.*

Mentee B$_L$A$_M$: I disagree, I think it could happen that a girl who is not interested in her future could be influenced by successful people by talking to them and learning about their achievements.*

Mentee A$_M$B$_M$: But examples of successful people are around us everywhere! You don't need to talk to them to know about them.*

Mentee A$_H$G$_H$: I agree with [Mentee B$_L$A$_M$]. One of my friends is really smart, but she does not have any plans for her future. No one mentors, guides, inspires or encourages her. When I try to advise her, she laughs because I'm her peer and I don't have enough experience and knowledge. That's why I think if e-mentoring exists, it would help her to shape her future even though she is not interested.*

4.3.7 *Post-study survey*

Mentees were asked to complete a post-study survey about their experiences with the e-mentoring program. It consisted of two parts: 1) open-ended questions; and 2) Likert-scale questions. It was answered by 8 out of 22 mentees.

Results showed that 7 of the 8 respondents described their e-mentoring experience as a positive one. 7 of the 8 respondents were satisfied with their mentoring relationship and described it as: "professional and nice"*, "respectful"* and an "amazing student/teacher relationship, she enthuses me"*. One mentee was not as satisfied: "Not as developed as I would have liked it to be, I feel like we only know each other on a name basis". Respondents said that the best thing about their participation was: "exchanging experiences"*, "discussion

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and dialogue"* and "My mentor's personality was extraordinary, she changed the way I think"*. On the other hand, two respondents had a different experience; they responded: "nothing special"* and "If enough effort had been put into it [from the mentees and mentor], it would've been a wonderful experience"*.

Regarding the problems faced during their participation, five respondents agreed that lack of persistent communication and long response times between posts were the main struggles. Three mentees had different responses. One said that the timing of the program was a problem as it clashed with final exams. Another mentee thought that the mentor was not initiative in communicating with the group. One respondent expressed that she was not comfortable with the platform (Edmodo). Seven respondents said that they gained knowledge about the fields from experts; one explained: "I learned more about the facilities and resources in our country related to the fields I want to pursue later on." Another responded: "My love for science has grown"*.

Four respondents' suggestions for improving the program were mainly to set fixed times for communicating with the mentors. One suggested working on related projects, while two suggested using another platform, "a more approachable platform for communication. Ex: WhatsApp". The second part of the survey showed that 5 girls indicated that their awareness of STEM careers had increased. All 8 respondents agreed that the e-mentoring program did not consume a lot of their time and that they were confident to write and express their opinions with their mentors. The mentees were asked if being in a group with other girls was distracting; 7 disagreed. Additionally, 5 mentees agreed that being in a group with others showed them different perspectives. All 8 respondents agreed that they would participate in other e-mentoring programs in the future.

4.4 Discussion

4.4.1 *Language, culture and mentoring*

Language is the main means by which social lives are conducted. Language as a means of communication is strongly connected with culture in several complex ways (Kramsch and Widdowson, 1998). It is important to highlight the absence of words for 'mentoring', 'mentor' and 'mentee' in the Arabic language. Kramsch and Widdowson (1998) described the relationship between language and culture by saying "language expresses cultural reality". People use words, phrases and language to refer and reflect on their experiences, ideas and common practices in their community and culture (Kramsch and Widdowson, 1998). The absence of the word 'mentoring' from the Arabic language reflects the fact that mentoring is not an established concept in Saudi Arabia and the Arab region, and helps explain the

participants' lack of understanding of what mentoring is.

This lack of understanding of mentoring is exemplified in the findings. The interviews showed that one mentee thought e-mentoring would be a Q&A session and another thought the program would introduce them to different majors. Both mentees expressed that what they experienced in the program positively exceeded their expectations. Some mentors misunderstood their role at the beginning. Two mentors described mentoring as guiding through a project or task. One mentor highly appreciated the idea of mentoring, but she was not "prepared" and did not know what to do.

Even though the study was on a small scale, it is important to highlight the diversity of demographics of the parents of the mentees. The study showed that the need for mentoring was not limited to girls with parents who had low levels of education, but also extended to those with parents who specialised in STEM or were highly educated. Through the interviews, the mothers (all three of them educated) showed the need for mentoring; all three mothers told stories about how they and their daughters were looking for someone to talk to, to help their daughters. All three mothers took some time in the interview to genuinely thank me for creating this opportunity for their daughters; they believed that mentoring was beneficial not just to individuals but to the whole of society. In their opinions, mentoring would create a more connected society; when girls at this age received voluntary help from people they did not know, they would have a stronger sense of belonging and would want to give back to their community in the future. The findings of the interviews show that both mentees and mentors shared their experience and knowledge gained from the program with people around them at school, home and work.

These findings help in understanding that the absence of mentoring in the context created a greater need for mentoring. This need was recognised by the mentors, mentees and mothers. The findings of this pilot study have implications for e-mentoring to be a base on which to develop communities with mutual benefits.

4.4.2 *Relationship trajectory*

The results showed low levels of interaction between participants and the discontinuity of the relationships. Different conditions may have led to the unsustainability of relationships. For example, groups with mentors who used an informal conversational style had high or medium activity levels (e.g. groups C and G), while groups with mentors who used a formal and distant style had passive mentees or mentees with a low level of activity. While I cannot exclude the fact that this could be due to chance and the fact that some mentees had mentors who were more conversationally active by nature, the interaction style likely played an

important role here. Mentor E_H gained a high activity level indicator because she wrote a couple of posts in a single day without getting any response from her mentees; she also addressed them as "students" and used words like "study group" and "lesson", which might explain why even though her activity level was high, her mentees' activity level was low. On the other hand, in Group F (Figure 4-6), Mentor F_L disregarded her mentee's first post in the group and created a new post which resulted in three unrelated posts (1 by the mentee and 2 by the mentor); this action of disregard from the mentor might have caused the mentee to discontinue her participation in the group.

However, some mentors made significant efforts to connect and build a relationship with the girls they were mentoring. Mentor B_M tried to make a personal connection and asked about her mentee's interests and hobbies, and they found out that they shared the same hobby. Mentor B_M contacted me when her mentee suddenly stopped responding to posts; her concern and interest in her mentee on different levels helped in increasing the interaction level of her mentee ($A_M B_M$). The mentee also spoke positively about her mentor in the interview: "I really liked my mentor and the idea of the program. She was very helpful and kind"*.

Creativity was a significant factor in the sustainability of the relationship in group G. In a single case, Mentor G_H sensed that the girls were losing interest and communicating less frequently, and she responded by initiating a small project with them to design a video game. The number of posts and interaction level increased among her mentees ($A_H G_H$, $C_M G_H$ and $A_L G_H$). In the first 4 weeks of the study, weekly materials about mentoring, topic suggestions and reminders were sent to mentors, yet mentors struggled to attract and engage their mentees. One mentor mentioned the benefits of such emails and suggested getting more tips during the study about mentoring and topic suggestions.

There was no interaction between mentees in any group, even though all posts were public and visible to all group members. This also may have weakened relationships in the groups. The results showed that mentees did not see the necessity of responding to each other; in addition, one mentee said that an introductory post about the members of the group would be helpful and support interaction among mentees in one group. The inability to interview passive mentees and low-activity mentors made it difficult to understand the reasons for their low engagement. Out of 22 mentored girls, 5 were identified as passive participants and one did not join her group. Access to log files was not possible and therefore I could not establish whether passive and low-activity participants were logging in and reading or were completely disengaged. The target group of mentees' commitment issues could be another reason for the unsustainability of the relationships. Girls at this age might feel burdened to commit to a long relationship.

Through the interviews, mentors gave their own explanations of mentees' low levels of interaction. Mentors had doubts about mentees' ability to talk confidently or felt textual communication created hesitation in terms of leaving a record. The results of the post-study survey contradict these thoughts. It shows that all 8 respondents felt confident to write and express their opinions with their mentors.

During the focus group session, an issue around the nature of the e-mentoring relationship was raised. It was readily apparent that the participating mentees were seeking flexible and less committed e-mentoring relationships than those provided by existing approaches to e-mentoring. Mentees explained that being in contact with more than one mentor would give them more information and knowledge about opportunities and work fields. Again, this different understanding of mentoring from participants could be a result of the absence of mentoring in the culture, as explained earlier.

Overall, two issues around participants' relationship were identified in this study. First, mentorship is not common in Saudi Arabia, so scaffolding in the platform could be designed to guide mentors and mentees in their mentoring relationships and help maintain these. Second, the findings raise questions about how to change the format of e-mentoring in terms of length, modality and commitment of e-mentoring programs.

4.4.3 *Overestimated effect of cultural context*

As discussed earlier, the concept of a mentor is new (for mentors, mentees and parents) in Saudi Arabia and this research has identified only a small number of articles addressing mentoring in this context (Abalkhail and Allan, 2015; Al-Mutairi et al., 2015; Ghawji et al., 2017).

From the outset, I was aware of the potentially significant cultural differences, particularly concerning the privacy requirements of the female participants (Al-Saggaf, 2011). This was the basis of my selection of text as the only means of communication between participants in the study. The findings showed that text communication was perceived as a major barrier. In all interviews, mentors and mentees reported that they felt the need to communicate in a more expressive manner, which would help them to understand each other and allow them to more readily express their personalities and characters. The majority of participants who responded to the post-study survey (6 out of 8 respondents) considered the communication method and platform as a barrier to their participation. Their complaints were around the long response times that the asynchronous method required and the unfamiliarity of the platform. The negative comments about the communication method were that the response times between participants were long, they were unable to express themselves easily

and that the act of typing consumed more time than other communication methods. One mentee of those who responded to the post-study survey suggested the use of a more commonly accessible platform.

All three mothers through the interviews indicated their acceptance of the use of different channels where they believed their daughters would genuinely benefit from this. This difference in cultural norms from widely reported expectations is likely to be related to the high rate of internet and social media usage in Saudi Arabia, which has led to the rapid adoption of such technologies (Bafakih et al., 2016; Winder, 2014).

The incorporation of parental involvement in the structured e-mentoring deployment in this study was a design choice that stemmed from the novelty of the mentoring concept in Saudi Arabia and the conservative nature of the Saudi community. I aimed to reassure parents about the process of mentoring (which was new to them) and to address anticipated parental concerns about their daughters talking to professionals who were strangers to them. Although parents had the opportunity to participate, the results show that none of the parents felt it necessary to do so. They believed that the rapid changes in the online world make it hard to control what their children watch, learn or use. They trust their children and trust that they raised them well to differentiate between right and wrong.

As mentioned earlier, my personal experience of being a Saudi woman in a STEM field has driven this research. As a Saudi my knowledge of the Saudi culture has also influenced my assumptions and expectations. The findings showed unanticipated insights regarding the cultural assumptions deployed in this study. The reasons behind the differences between what I expected and what was found, could be related to the differences in the way of thinking between me as an adult and between the teenagers (the mentees) and to the differences in the experiences that I had when I was their age. Another reason could be that the high use of the internet and social media in Saudi Arabia made Saudis more flexible to new technologies and online experiences.

4.4.4 *Measurement of impact*

The quantitative data on interaction frequency and duration did not meet expectations. Some mentors posted many posts that did not result in any replies or even likes. Others posted more than one different post in a single day without any response from their mentees. By examining interaction sequences (e.g. responses to others vs. isolated posts), I noted that high participation did not imply interaction between members and so could not be a measurement of success.

Conversely, qualitative data showed the impact of the program on the girls despite the low levels of interaction. The program raised their awareness about Saudi females in STEM and available opportunities for them in the future. Mentors and mentees shared their e-mentoring experiences with colleagues, friends, school and family. The study made a positive impact on the participants that resulted in them sharing their experiences with others.

Three years after the study, I followed up with the participants to gain insight into whether the e-mentoring program had influenced them. Only three responded. Mentee $A_M B_M$ stressed that her love for science grew even more after her mentoring relationship with her mentor. She also mentioned that she still remembered her mentor and how she had a positive influence on her. She asked if there were any upcoming e-mentoring programs. Mentee $B_L A_M$ explained that she had joined the project as a new experience. The major she was interested in was not among those of the participating mentors, which might explain why she had a low activity indicator. She suggested for wider options of majors to be added so that more girls would benefit. Mentee $A_H G_H$ told me that her participation in the e-mentoring program had made her more determined about her choice. She added that the program had changed her perspective on the future and widened her ambitions, because she had learned about the different mentors, their majors and their careers.

The results show that the level of participation was not a measure of the level of interaction between participants and a low level of interaction did not necessarily imply the ineffectiveness of the program. Therefore, any evaluation criteria must include the impact on mentees and mentors. Measurement of impact needs to consider various aspects of the envisaged benefits of e-mentoring on mentors and mentees, depending on the motivation behind the program.

4.5 Summary

This study was the first systematic investigation of e-mentoring in Saudi Arabia. The program aimed to encourage high school girls in Saudi Arabia to pursue STEM higher education studies and raise their awareness of STEM career opportunities. The objective was to deploy an e-mentoring program in a structured configuration, where mentors and mentees were matched and regularly contacted each other. The findings from this study show low levels of engagement from both mentors and mentees. The results of this pilot study indicate that the structured e-mentoring configuration had a degree of effectiveness, but was not sufficiently engaging. In particular, the qualitative data from the interviews and the focus group deepened my understanding of the expectations of participants about e-mentoring. Insights from the findings, especially the focus group with mentees, imply the need to further investigate the

requirements of e-mentoring in terms of the relationship, commitment and opportunities for alternative and more flexible forms of e-mentoring.

Chapter 5 Co-Design Workshops

5.1   Introduction

In Chapter 4, the results from Study 1 (the pilot study) indicated that the structured Edmodo e-mentoring configuration was effective to some degree, but not engaging enough. Insights from interviews and a focus group with participants in the Saudi context gave direction to further investigation of the requirements of e-mentoring in this context. To be specific, the focus group with the participants in Study 1 showed interesting findings about how the participants described their e-mentoring relationships. They wanted more freedom and flexibility in their e-mentoring relationships, which contradicts the approaches of previous e-mentoring literature (Bierema and Merriam, 2002; Single and Muller 2001) where they encouraged frequent and committed meetings between a mentor and a mentee and long-term relationships. These findings made me take a step back and conduct two co-design studies (Studies 2 & 3) with two different age groups of girls to develop a better understanding of the requirements of e-mentoring (Table 5-1).

Table 5-1 Summary of the two studies showing the numbers of participants, ages of participants and purpose of each study.

Study	Number of participants	Age of participants	Purpose of the study
Study 2	30	18–22	Understanding the requirements for e-mentoring through workshops (brainstorming, bodystorming and prototyping)
Study 3	15	17–18	Validating through designing an e-mentoring product by participants

Design practice has been influenced by changes in the perspective of user-centred design research. In co-design, the people who will benefit from the design (the users) play a large role in gathering knowledge and generating ideas; they play the role of the 'expert on their experience'. User participation in technology co-design aims to elicit knowledge and ideas from expert users who know the problem and have been in the relevant situation (Vines et al., 2013). In addition, co-design gives power and agency to those who are usually ignored in the process (Vines et al., 2013). Giving people power and agency to participate in the design of systems they will use results in successful participation in design by incorporating their understanding of the challenges and barriers. As discussed earlier (in Chapter 2), the target group of this research is generally considered to be an understudied population; based

on the literature review conducted in this research, no studies have been identified, especially in the Saudi context, on employing co-design or user participation in the e-mentoring context. Therefore, the employment of co-design workshops was intended to empower the target population in addition to gaining a deeper understanding of the perceived barriers to and opportunities for e-mentoring from their point of view. This chapter addresses the research question of identifying the factors that contribute to the design of a STEM e-mentoring system for teenagers and young women in the Saudi context.

This chapter describes the design of Study 2, which consisted of three co-design workshops over a period of 3 weeks with first-year female undergraduates to understand the participants' expectations of e-mentoring. Each workshop is presented in detail, then followed by description of the data collected from each workshop. Then Study 3 is described, which was a one-session workshop with schoolgirls (aged 17–18), followed by description of the data generated from that workshop. The following section reports the thematic analysis of the discussions and presentations from both studies (Study 2 and Study 3). Finally, a reflection on the findings is discussed which indicates the need to move from structured e-mentoring models towards other approaches.

5.2   Method: Study 2 – Co-design with Undergraduate Female Students

The lack of understanding of mentoring, the impact of the program on the mentees despite the low levels of interaction and the overestimated effect of the cultural context were the findings of the structured Edmodo e-mentoring deployment (Study 1) and the subsequent interviews and focus group. To build on these findings, three two-hour workshops were conducted once a week over a period of three weeks with female first-year undergraduate students, with the aim of gaining a deeper understanding of the perceived barriers to, and opportunities for, e-mentoring.

The three workshops were conducted with the same group of participants. Different design methods were used in each of the three workshops: problem statement stories, brainstorming, bodystorming and prototyping. The second and third workshops responded to the outcomes of the preceding ones. All workshops were conducted in Arabic, audio-recorded and photographed. The audio recordings were transcribed, then translated from Arabic into English. Full ethical review was conducted and approved by the Faculty of Science, Agriculture and Engineering at Newcastle University.

5.2.1   *Participants*

In this study, 30 female first-year undergraduate students (aged 18–20 years) were recruited

from a community college. In Saudi Arabia, a community college is an educational institute that grants diploma certificates (2 years) and bachelor certificates (4 years) in applied studies such as databases, programming and computer networks. Most students studying at community colleges come from low socioeconomic backgrounds.

At the end of the first workshop, participants were asked to complete an online survey about themselves and their families, which included demographic data (their ages, plus the ages, education levels and professions of their parents) and their access to female role models. A key consideration in the choice of first-year undergraduates was that they had had the experience of choosing a STEM field without access to mentoring; in this respect, they were identified as experts through experience.

Participants are identified in the following manner: the number of the study combined with the number of the participant. For example, participant number 3 from Study 2 is identified as S2P3. The participants are numbered based on the order of their quotes.

5.2.2 *Workshop 1: Problem statement stories*

In the first workshop, the problem space was introduced to the participants using a one-minute story (animated video) that I produced specifically for the workshop. Gruen et al. (2002) named stories in the research phase of a design process "problem statement stories". Stories are tools used to encourage others to share relevant or similar situations from their own experience. Most people understand and empathise with stories that have detailed characters, settings, goals and challenges. Empathising with stories prompts innovation and creativity (Gruen et al., 2002).

The non-narrative video had brief English captions in some scenes (Figure 5-1, Figure 5-2, Figure 5-3). It described a story of a 16-year-old Saudi girl who was passionate about space science and wanted to study and have a career related to space (Figure 5-1). Her father was an accountant and her mother was a teacher; they did not have the background needed to help or guide her (Figure 5-2), so she did not know who to ask or where to get advice about how to further her ambition (Figure 5-3). In order not to overly influence the participants, the term 'mentoring' was not mentioned in the video or at any time during the workshop. After the video ended, they were asked if they would like to watch the video again or if there were any English words that they did not understand.

Figure 5-1 Screenshots from the video presenting the main character, Sara
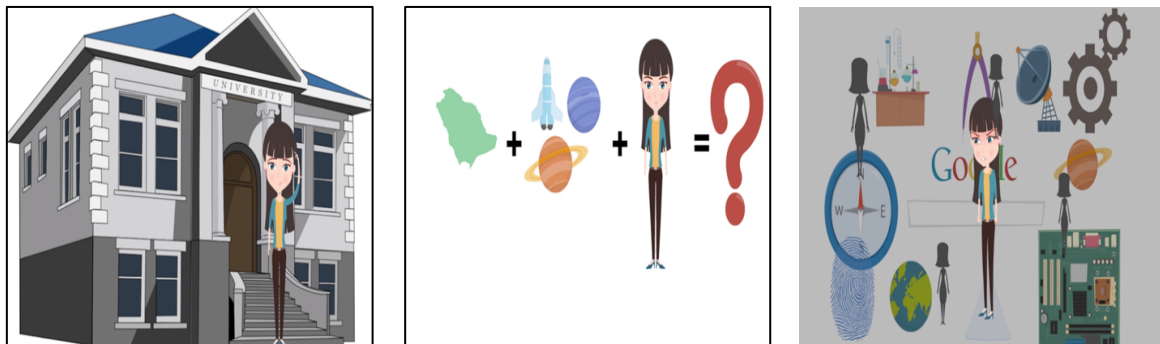
Figure 5-2 Screenshots expressing Sara's goal and challenges
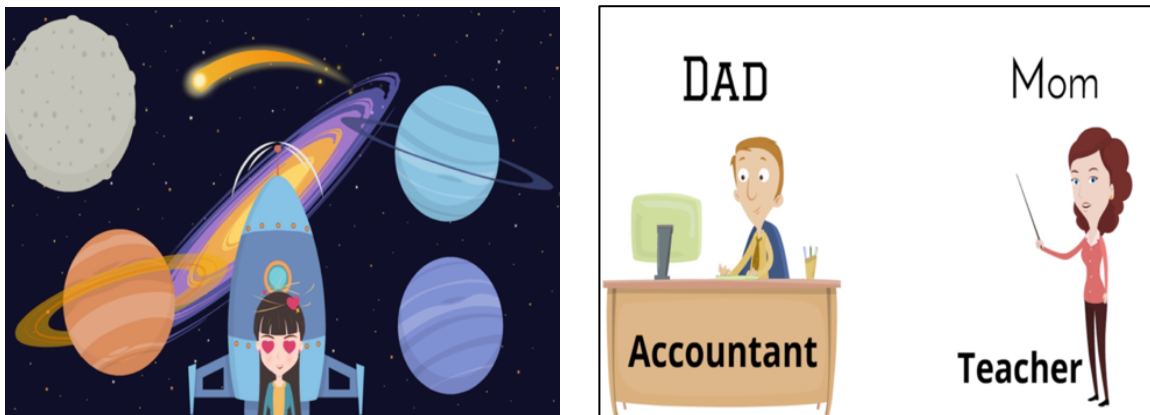
Figure 5-3 Screenshots displaying the setting of the story (Sara's love of space and her family background)

The participants were asked to define the challenge and the factors that contributed to the problem from the story. Participants were divided into five groups and discussions around the story and the challenges faced by the female character, Sara, were held within each group. Each group presented to the rest of the participants what they understood from the story and what they felt were the main problems.

Then each group brainstormed ideas to solve the problem and organised their ideas on paper boards using markers, printed icons and sticky notes. The printed icons were a group of random icons that represent mostly technology and connectivity icons (Figure 5-4). Each group received a random set of different icons. Although using the icons was optional, the aim was to help them visualise and present their ideas. All five posters were hung on the wall. Each group presented their idea to the other groups.

Figure 5-4 Printed icons that were given participants to help them with their posters

5.2.3 *Data from Workshop 1*

After viewing the animation video, one girl from each group presented their own view of the problem presented:

> S2P1 from Group#1: She wants to be an astronaut, she looked and searched, but she didn't know how.*

> S2P2 from Group#2: She wants to be an astronaut, but our society does not support such a profession. She might also have financial problems. It was clear that she tried to reach out to others, but no one helped her.*

> S2P3 from Group#3: She needs someone to guide her to fulfil her dream.*

> S2P4 from Group#4: Her parents are busy and therefore she did not receive the support she needed. She needs support from others outside her family members.*

> S2P5 from Group#5: She has trouble managing, managing how to apply, managing her time, managing the pressure. She needs help.*

Each group brainstormed solutions to resolve the problem presented in the workshop. They showed their ideas on posters; all groups hung up their posters and presented their ideas to the other groups.

Group#1

The application is called *Wasil* (which means 'connection' in English) (Figure 5-5). The application has two users, *Khebra* (an expert) and *Mustafeed* (a beneficiary), and it aims to connect experts and beneficiaries. The expert signs up and provides her information, expertise and field. The beneficiary signs up and looks for an expert in a certain field. The app provides communication between the expert and beneficiary via video/audio call, chat or messages. The app shows job advertisements and courses related to the field. A group of beneficiaries can connect with one expert. The group of beneficiaries support each other and share knowledge about the field they are interested in.
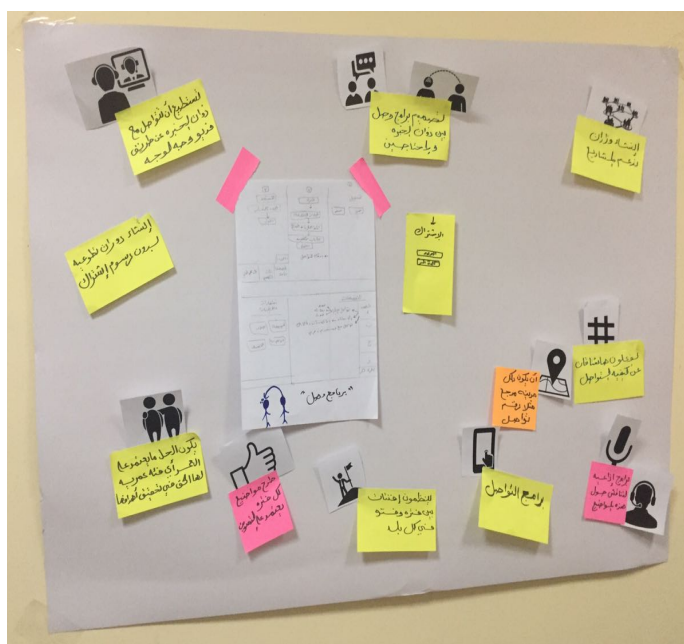
Figure 5-5 Poster by Group#1

Group#2

This group presented a flow chart of events about how the girl will solve the problem (Figure 5-6). First, she will look into books and YouTube to find some information. She will use Twitter to create a hashtag to be connected with other girls who are facing the same problem. This group of girls will create campaigns and leaflets to educate and raise awareness about the field. Then they will come up with an app idea. The app will help anyone who wants to learn more about the field. They can sign in and connect directly with professionals available. One of the features of the app is that it supports video/audio calls. Professionals provide their information and information about their field and workplace, and how to become involved in this field.

Figure 5-6 Poster by Group#2

Group#3

Their solution was an app that is supported by a network of experts (Figure 5-7). The app focuses on creating a connection. Members will use social media to increase the visibility of their app and people will become aware of it. The app will support girls from all around Saudi Arabia. Different fields will be presented and, for each field, it will show what opportunities you have if you study this field. Questions and problems will be sent through the app's email and will be answered and solved by experts. Answers will be provided in a short period of time.

Figure 5-7 Poster by Group#3

Group#4

This group's app is called *Help me* and a web version is available as well (Figure 5-8). There are sections in the app; one section is for books where you find books related to fields you want to know about. Another section is for trusted people, who provide verified information about themselves. A girl can connect with them through chat. She can create a group with experts and others to exchange ideas and knowledge. A user can share an image or a video with other users of the app and share a link about the app or content of the app on Twitter via a share icon, so people know about the app and share knowledge. Another section is gaming; users choose a field, for example 'biology', and they will be asked questions that test their level of knowledge about biology. It's fun and they will learn new things. If an expert posts a video or an article, the users will be notified. You can connect with an expert via the contact information they provide (email, phone …) or you can use the chat. There will be a section for job announcements.
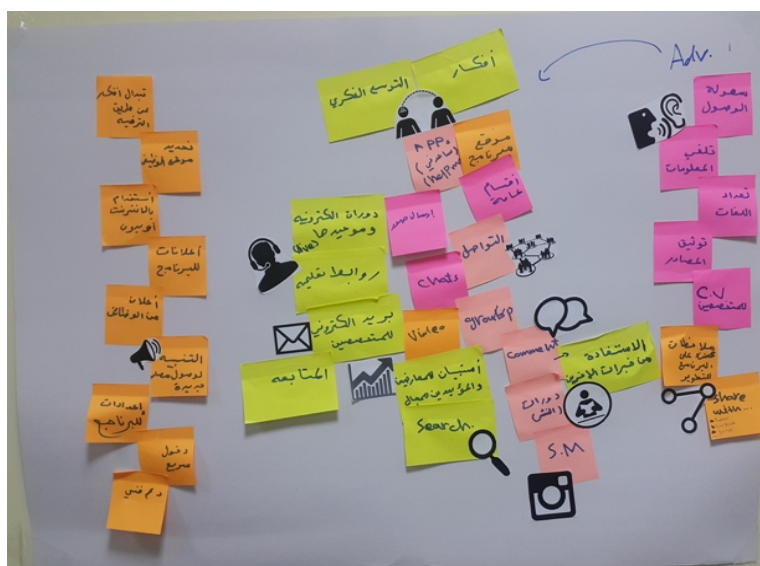
Figure 5-8 Poster by Group#4

Group#5

Their idea was an application called *Mehan* ('professions') (Figure 5-9). At the start, a new user will play a game to test their preferences and knowledge about the field and learn new information. The game has levels and the user will become more knowledgeable at each level. A user can connect with professionals. The app provides financial support to help girls study the field of their choice. Users can advertise themselves to obtain job offers. The app is easy to use, supports all age groups and communications between a girl and an expert are via audio or video call.

Figure 5-9 Poster by Group#5

5.2.4 *Online survey*

At the end of the first workshop, a link to the online survey was shared with the participants and they were asked to use their devices (laptops or phones) to access the survey. All 30 participants agreed to answer the survey. The first part of the survey contained demographic questions about their families and the second part was about their access to female role models. The online survey was in Arabic.

5.2.5 *Workshop 2: Bodystorming*

In the second workshop, participants were introduced to the notion of mentoring and how their ideas, generated in the first workshop, related to the concept of mentoring and connecting with professional women.

As the concept of mentoring is not a familiar one in Saudi Arabia, bodystorming was used as a method to make the idea of mentoring more tangible. The role of acting in bodystorming supports empathy towards users and helps in becoming familiar with unfamiliar situations, which results in better understanding of the problem (Oulasvirta et al., 2003). Rather than using familiar alternatives such as personas, participants were asked to play the roles of the mentor and the mentee, to support their understanding of e-mentoring and the production of ideas for realising it (Schleicher et al., 2010).

A number of different situations were acted out by two of the participants, S2P6 as a mentor and S2P7 as a girl (mentee); each had a label on her back stating that she was the mentor or the mentee (Figure 5-10). All the scenarios were acted out by the same pair while the rest of the participants were observing, identifying problems and suggesting solutions/actions. The first scene was the starting point based on the results of the previous

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workshop, which indicated contacting a professional as the solution to the problem. The following scenes were based on the suggestions and discussions of the observing group members. The first scene was that of a busy professional mentor trying to be contacted by a mentee. Each time the mentee tried to contact the mentor, she could not. Group members initially suggested scheduling meetings where the mentor displayed her availability and the mentee chose a date and time slot. In the simulated meeting (the second scene), the mentor and the mentee sat silent for extended periods of time, leading the group to conclude that simply agreeing on a day and time was not enough. Agendas for such meetings should be established beforehand to include the topics to be discussed. Another scene that was acted out was that, after 15 minutes of the scheduled meeting, the mentee had nothing to ask or discuss; this led the group to discuss that the time slot length should not be fixed and the length of the session should be an option to determine beforehand (Figure 5-10). The final scene was suggested by the girl who acted as a mentee. She suggested that the mentee skipped the scheduled meeting and the mentor waited for her.

Figure 5-10 Development of scenes in bodystorming workshop
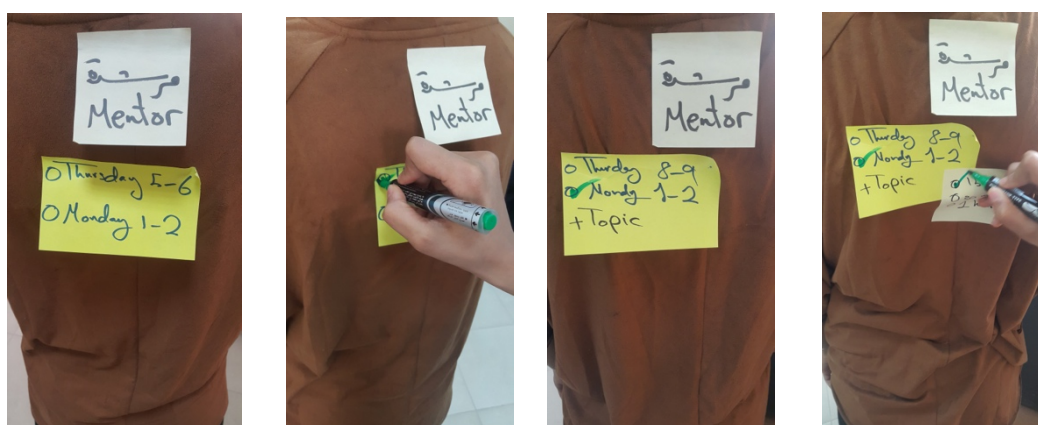
5.2.6 *Data from Workshop 2*

The acting out of the scenarios resulted in the emergence of topics regarding mentoring that were raised by the group of participants and documented on a board in the same room (Figure 5-11). Some of the topics were raised by the group members and some were directed by me based on my previous knowledge about the nature of mentoring.

Figure 5-11 Ideas discussed through the bodystorming workshop

Scheduling with a mentor

Participants discussed that because mentors are usually busy, they should be the ones who display their schedules and availability. In meeting invitations, the mentee would specify the topics that they wanted to discuss, choose the mode of communication based on options the mentor specified and set the length of the session (suggestions ranged over 15–60 minutes). The participants emphasised that the first meeting should not be long, as the mentee might not be comfortable with the mentor. The participants thought that there was a chance that any two individuals (strangers) might not be comfortable talking to each other; therefore, to reduce awkwardness or discomfort, they suggested that the first meeting should not be long.

The final scene of the mentee not showing up to the meeting triggered a discussion on how to manage this situation. One problem was that scheduling and not attending the meeting would lower the chances for other mentees who were more committed to benefit from the mentor. The other problem was that it would be a waste of the mentor's time. One suggestion was to have a waitlist for each mentor; if the mentee with the original appointment did not show up, the mentee with the next waitlist appointment would have her turn. The participants discussed penalties for not showing up to prevent it from being a habit for mentees. If a mentee did not show up for three meetings, the penalties could be: a) she would be banned from scheduling a meeting for some time (for example, 1 month); b) she would be allowed to schedule meetings on the waitlist; or c) she would be charged a fee. The mentor was entitled to excuse a mentee in case the mentee apologised for her absence and it would not be credited

as a "no show" on the mentee's record. For each meeting, a mentor would mark the attendance of the mentee with present, absent or apologised for not showing up (excused). Another suggestion was to charge a small fee for scheduling a meeting (Figure 5-12).
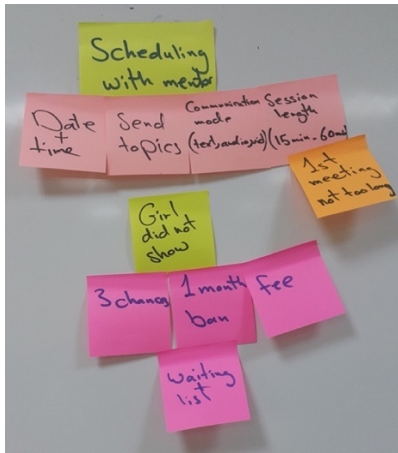

Figure 5-12 Discussion points around scheduling with a mentor

One mentor vs. many mentors

It was not clear how the participants were visualising the mentoring relationship, so I asked whether a mentee would be connected to one mentor or many mentors. There were different opinions, but they agreed that it would be optional for the mentee to be connected with one or many mentors. The group of participants who were favouring being connected with one mentor said that they would want to keep their mentor updated about their progress and that they would contact her if they needed help because she (the mentor) had previous knowledge about her (the mentee). They stressed that this one person (the mentor) would give them the moral support they needed. Discussion around being comfortable with the mentor (who was a stranger) was raised again. They explained that sometimes you do not feel connected with someone and they did not want to be committed to a person they did not feel comfortable with. The participants said that if they liked the mentor and would like to keep in contact with her, they would schedule another meeting with her or subscribe to weekly or monthly meetings with her (Figure 5-13).
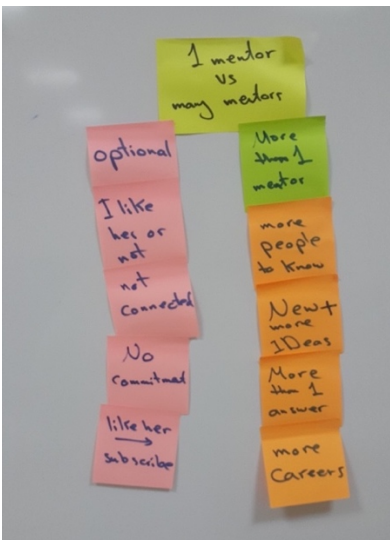
Figure 5-13 Discussion around being connected to one mentor vs. more than one mentor

The other group, who favoured being connected to many mentors, explained that they would benefit more from connecting with more people. They would be aware of more career options, have different opinions and answers to their questions and learn new ideas and perspectives.

Live sessions

During the discussion around the duration of each mentoring meeting, participant S2P8 suggested "live sessions" for longer periods of time and shorter sessions for one-to-one meetings; she explained: "live sessions like the ones we view on Instagram" (Figure 5-14). The group liked the idea and started stating the benefits of live sessions. One girl said that if she did not like what the mentor was saying or the way she thought, she could easily disconnect from the session without disturbing the mentor. Another girl said that it would help shy girls who found it hard to ask questions. It would also benefit the group of girls attending because one mentee might ask a question that others had not thought about.
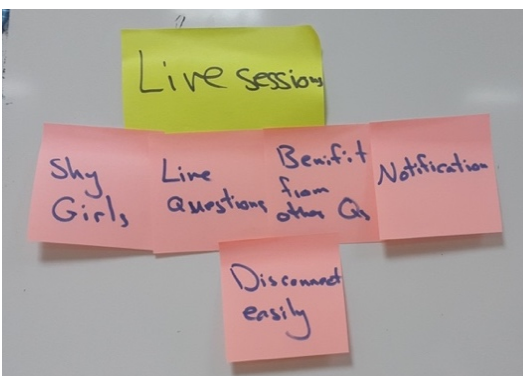

Figure 5-14 Live session suggestions

Mobile app vs. web platform

Another confusion that needed to be cleared up was that there was a sense that participants were referring implicitly to the use of mobile apps (Figure 5-15). I asked them directly if this was what they preferred. The participants were divided into two groups, one that preferred mobile apps and the other that preferred web platforms. The first group described the benefits of using mobile apps: getting notifications and reminders about meetings or live sessions on their phone and ease of access as they carried their phones everywhere with them. The other group started by stating the disadvantages of developing the idea as a mobile app. They said that mobile apps consume phone memory space and cause it to lag. They preferred websites or web platforms because PCs and laptops had wider screens in comparison to mobile phone screens. They also mentioned that a web version would be accessible from both a PC/laptop and a mobile phone.
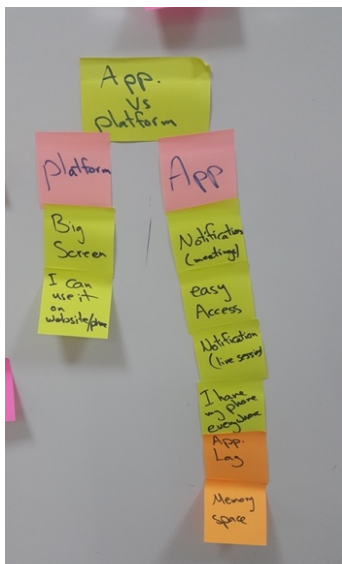

Figure 5-15 Mobile apps vs. web platforms

Appreciating mentors

The discussions were mainly about the mentees and the process. To get a better understanding of how the participants were thinking, I asked them to think about the mentors and why they would volunteer and continue mentoring. Some participants suggested that feedback was a good way to encourage mentors. This feedback could be in the form of ratings of multiple questions after each session; for example, one question could be: On a scale from 1–10 how helpful was the mentor? Some participants also suggested optional comment boxes. Participant S2P2 said that girls her age usually do not write comments. In the case of negative or bullying comments, the mentor could delete the comments and they would not be visible on her page. The administrators would have access to all comments, even deleted ones,

because if one mentor was getting a lot of negative comments it might be an indicator that the mentor was not good with the mentees. The mentor with the highest evaluation would be "mentor of the month". Some participants suggested that mentors should get financial support or be honoured by the government or any other organisation.

Another suggestion was to hold an annual meeting with the mentors and mentees to honour the mentors and network with their mentees. Participant S2P9 suggested that a mentee should share her achievements that were accomplished with the help of her mentors on her profile or social media; for example, "I applied for computing school with the help of mentorA and mentorB". This would be a way to appreciate her mentors. Another way was to allow mentees to invite potential mentors to join the program (Figure 5-16).
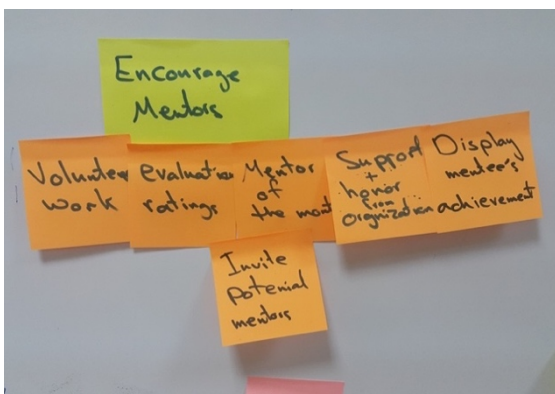

Figure 5-16 Encouraging professionals into mentoring

Sharing with others

The idea of sharing their achievements in appreciation of the help of the mentor inspired the participants with the idea of sharing with others to benefit them and share knowledge. Mentees would share their mentor's profile via WhatsApp, Twitter or any social media platform. If a mentor was asked a written question that she found frequent among mentees, the mentor could reply and publish the answer so that all the girls would be able to read her answer. The most frequent questions would be publicly displayed on the mentor's profile page, which might answer some questions without needing to schedule a session. Another suggestion to maximise the benefit was the idea of groups, where a group of mentees joined one mentor (Figure 5-17).
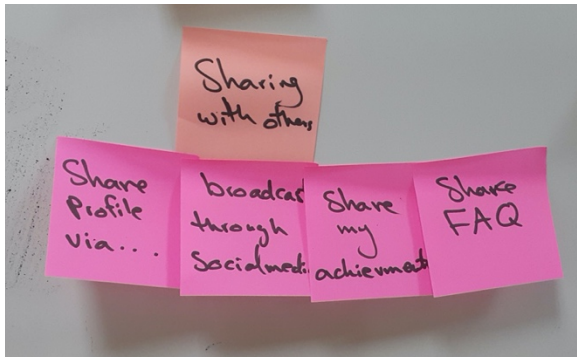
Figure 5-17 Discussion points on sharing with others

5.2.7 *Workshop 3: Paper prototyping*

In the final workshop, the participants engaged in a process of low-fidelity prototyping using papers that had a rectangle printed on them. They were told that theses rectangles could represent a mobile phone screen or a computer screen. In this session, the aim was not to produce detailed user interface designs, but to complete their understanding and validate ideas generated in the previous workshops. Paper prototyping with young users is a preferred method for capturing, understanding and reflecting on the requirements and needs of the young participants (Glasemann et al., 2010).

Half of the participants did not show up to this session for unknown reasons; therefore, the 15 present participants organised themselves into three groups. They were asked to sketch and represent their ideas on the screen templates provided, based on what they learned in the previous workshops.

5.2.8 *Data from Workshop 3*

Each group presented and displayed their sketches to the other groups. All groups referred to their sketches as mobile apps.

Group#1

These participants sketched the home page of a user. The sketch showed a space for the time line, where they got updates and notifications. It displayed a profile image, the number of following and followers, and icons for editing the profile and logging out (Figure 5-18, top). The sketch showed that fields such as computer science, science, chemistry and law were in different sections (Figure 5-18, bottom). In each section, a user could schedule a meeting by selecting a date and time. The bottom navigation bar showed a profile icon, a message icon for private message between a mentor and mentee, a calendar that showed scheduled meetings and a search icon to search for mentors.
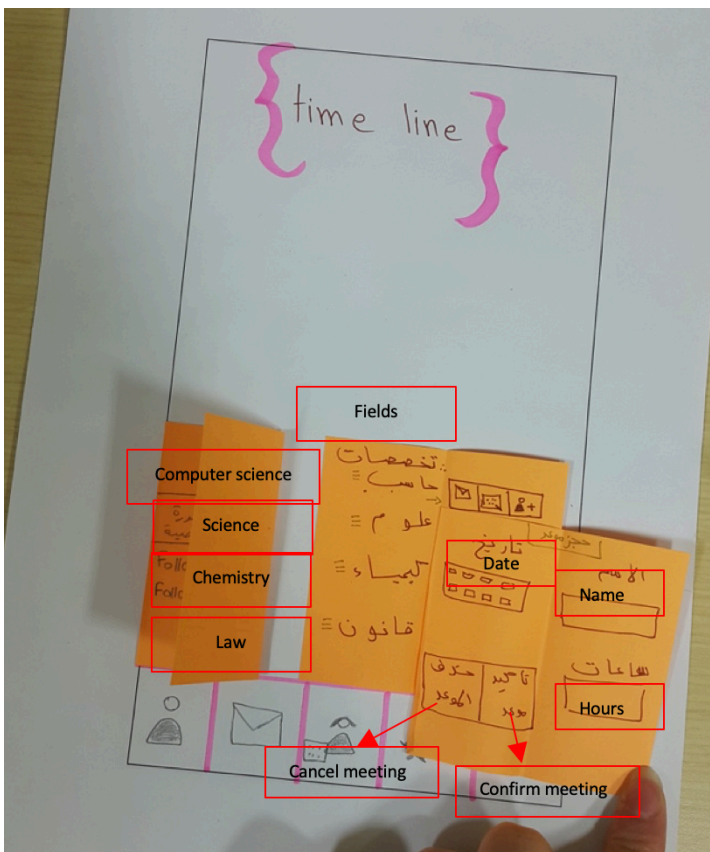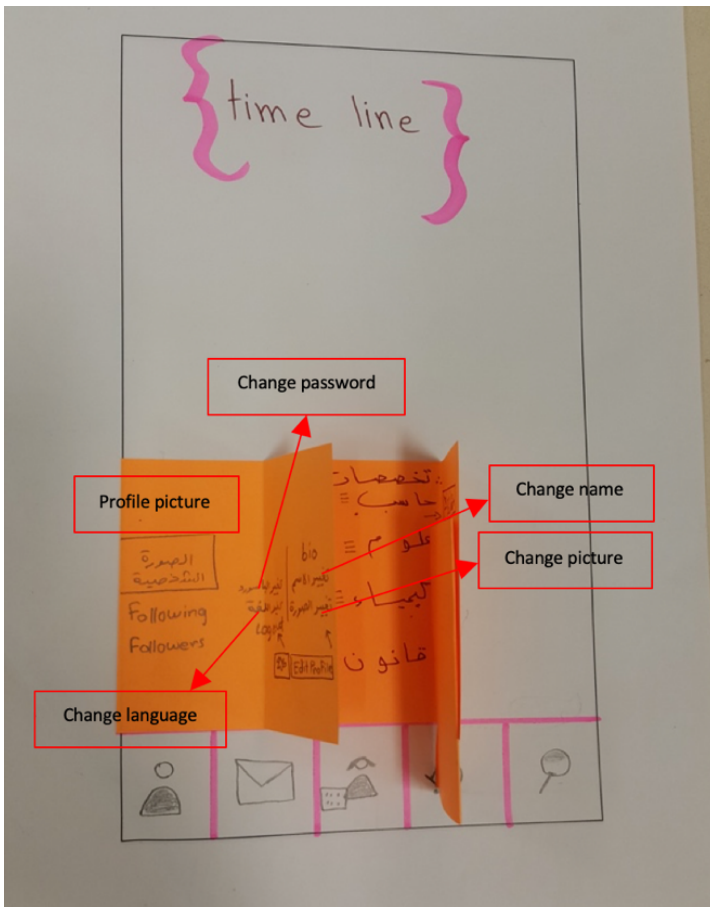
93

Figure 5-18 Annotated sketch of Group#1

Group#2

Their page was divided into three sections. The section on the left contained (starting from the top): 'my account', 'fields' and 'appointments'. The participants used orange and yellow sticky notes to demonstrate that selecting the meeting icon displayed the available times for the mentor who the user was following and the live session notifications (Figure 5-19, bottom). At the top of the middle section, the round icons represented the live sessions in action for the mentors. Each round icon had the mentor's name, for example mentor Sara. The mentees who attended a live session could post questions which would be shown at the bottom of the middle section. The right section showed a 'message' icon with a notification for a new message, a 'pioneers and volunteers' icon where a user could search for a professional, an 'advertisements' icon for courses and jobs, and a 'logout' icon.
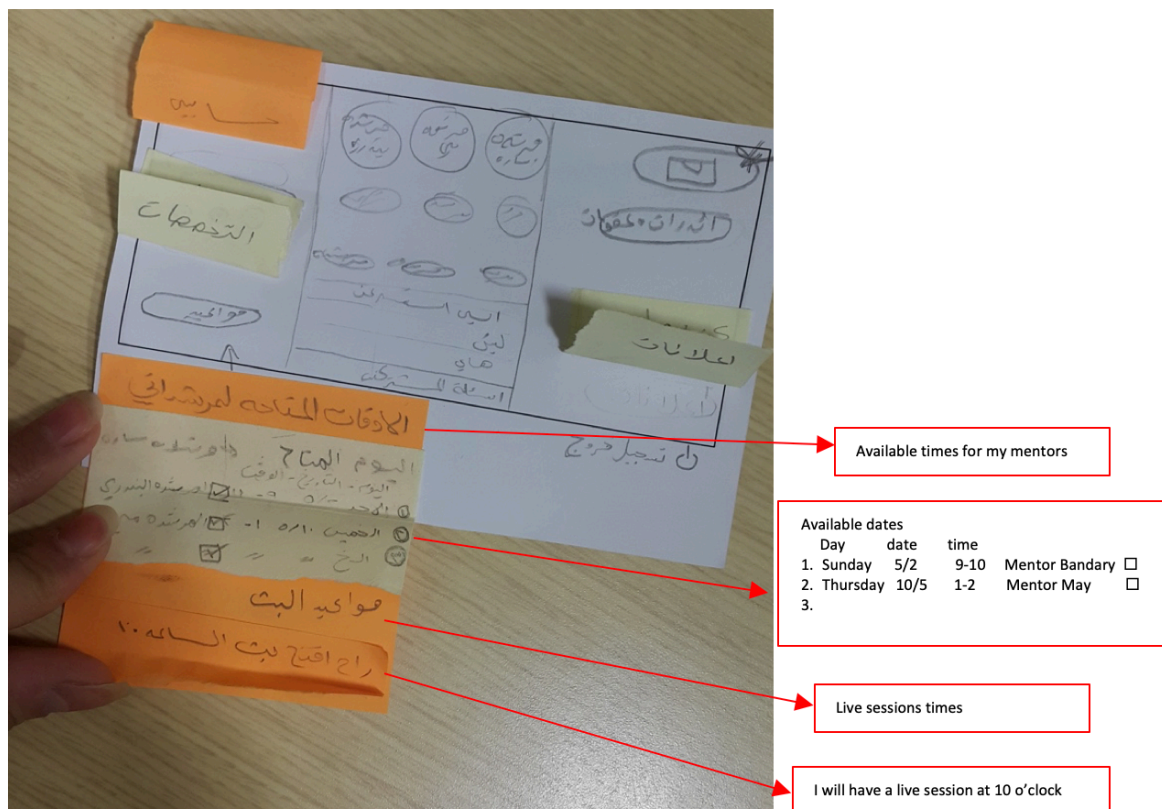
Figure 5-19 Annotated sketch of Group#2

Group#3

In Figure 5-20, the top sketch shows the main page. The top navigation bar consisted of (from the left): 'settings', 'notifications' and a search bar. In the middle, it showed a profile image and the number of following and followers. At the bottom of the page, there was a 'messages' icon for private messages. Under 'settings' there was a 'time' icon; when selected it displayed the bottom sketch (Figure 5-20, bottom). The 'time' page showed several fields (starting from the left): name of the mentor, day, time, date, presentation and attendance. The 'presentation' field specified whether the presentation by the mentor was a 'lecture' or a 'course'. A 'live' icon was at the bottom left corner for live sessions.
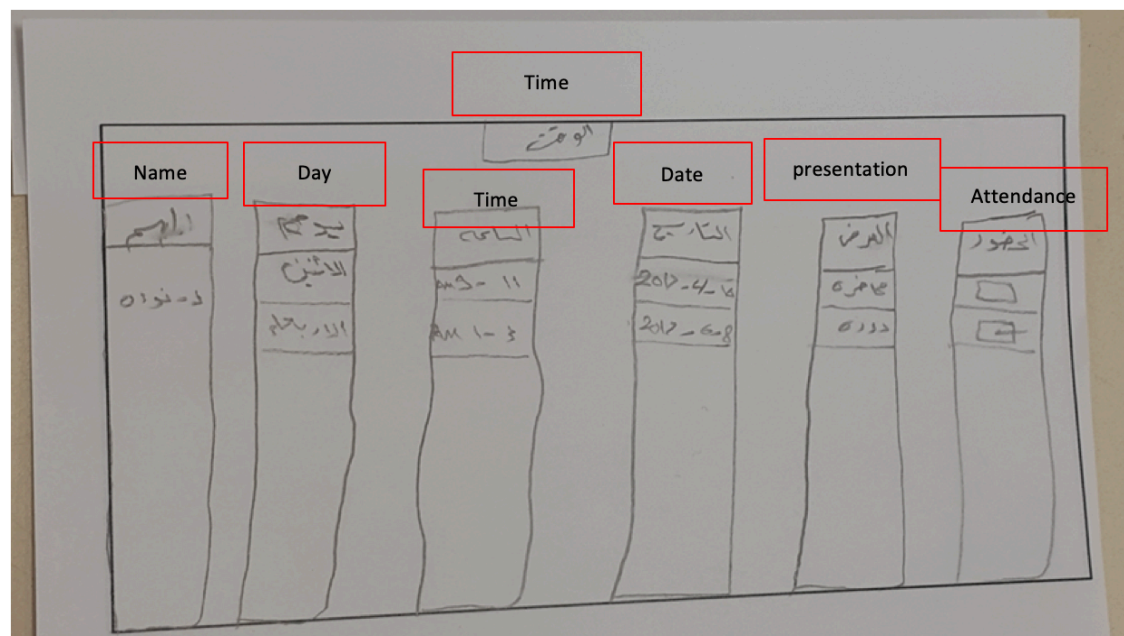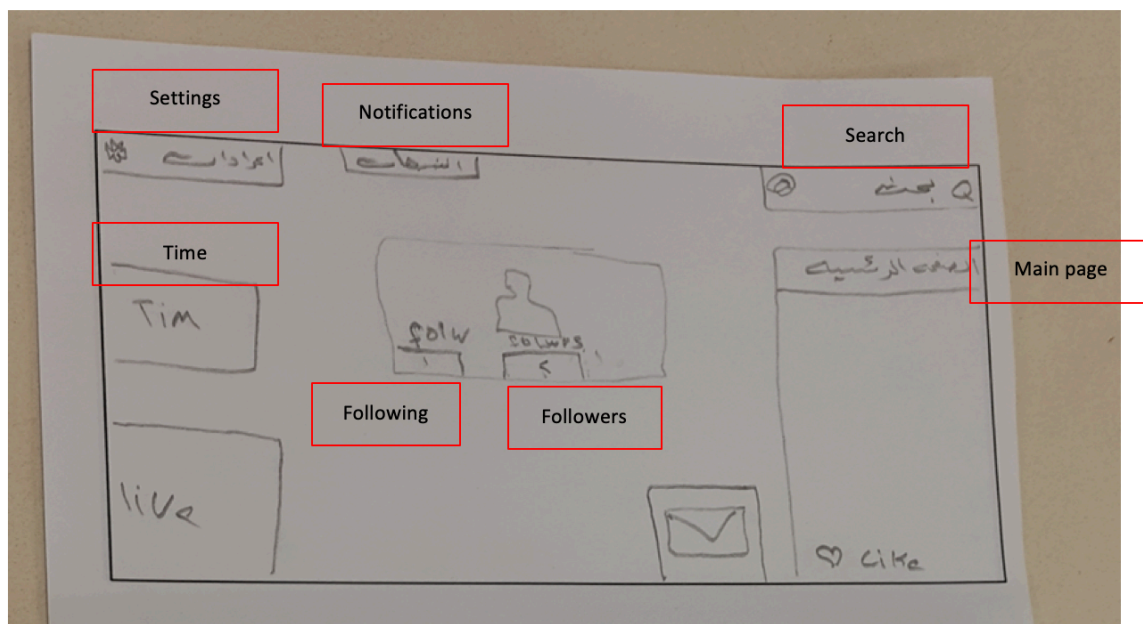
Figure 5-20 Annotated sketches of Group#3

5.3 Method: Study 3 – Co-design with High School Female Students

This study aimed to reflect on and extend the understanding of e-mentoring arising from both the structured Edmodo e-mentoring deployment (Study 1) and the co-design workshops with undergraduates (Study 2) and to this end, a co-design activity with female high school students was conducted. As participants from the previous workshops had demonstrated their understanding of and ability to design and set guidelines for e-mentoring, I aimed to explore the possibility and the capacity of the younger targeted population (female high school students) to design their own approach to e-mentoring. The workshop also aimed to validate the findings of the co-design workshops with undergraduates with the targeted population of

this research, who were approaching the point of having to choose a STEM field (i.e. the same age group as in the structured Edmodo e-mentoring study). Participants were asked to complete the same online survey given in Study 2 at home (with the help and knowledge of their parents). The session was audio-recorded and photographed. Translation from Arabic into English was applied when needed. Full ethical review was conducted and approved by the Faculty of Science, Agriculture and Engineering at Newcastle University.

5.3.1 *Participants*

Fifteen schoolgirls (17–18 years old) were recruited from a private school. Private schools in Saudi Arabia are non-government, have high standards of education and require tuition fees for enrolment. Participants from this school came from higher socioeconomic backgrounds than the participants in Study 2. After conducting Study 2, I recognized that all the participants were from low socioeconomic backgrounds. In Study 1, the need for mentoring was not limited to mentees with parents who had low levels of education but also extended to those with parents who specialised in STEM or were highly educated. Therefore, participants in Study 2 and Study 3 were from different socioeconomic backgrounds to examine if there are differences in requirements and designs between the two groups.

The co-design workshop was conducted at the school campus with the approval, consent and collaboration of the administration of the school and the parents of the students. Participants are identified in the same manner as in Study 2. In this study, participants are identified by S3 followed by the number of the participants (e.g. S3P4). The participants are numbered based on the order of their quotes.

5.3.2 *Workshop: Design the box*

A two-hour co-design session was conducted at the school campus. The stated goal of the workshop was to design an e-mentoring product that realised the type of e-mentoring experience that the participants wanted.

The purpose of this activity was to translate participants' ideas and needs onto a physical object, 'the box'. The previous workshops, which allowed the participants to express their ideas physically on posters and sketches, gave a better visualisation of what ideas and thoughts they had. The box here was the medium where information was physically presented (Gray et al., 2010). The outcome of this workshop was a box which captured and reflected the needs of the participants (Wienhofen et al., 2014). Wienhofen et al. (2014) described the outcome of this activity as a product that gives prospective users the "I want this and I want it

now" sensation. The activity goes through three phases: an introduction, box design and sharing by "selling" (Gray et al., 2010).

In the introduction phase, the girls were introduced to the overall concept of mentoring through a short oral presentation on the concept of mentoring, how mentoring is applied in different contexts and the different mentoring relationships. Since the purpose of this study was to validate the findings from Study 2, these findings were not introduced to the participants of this study in order not to influence them beforehand. After that, they were divided into three groups. Each group was given time to discuss ideas about how they imagined their mentoring experience. The groups were asked to think about and discuss mentoring from (but not restricted to) different perspectives such as relationship (e.g. one-to-one or one-to-many), level of commitment and mode of communication.

In the second phase, they were set the challenge of designing the box, which depicted an e-mentoring product as if it were a tangible product sold on shelves. Each group was given a cereal box covered with white paper, markers, printed icons (Figure 5-4) and sticky notes. They were asked to start designing their e-mentoring product (Figure 5-21). The product should identify the name of the product, a tagline describing it, key features and requirements.

Figure 5-21 Participants in session designing their products

By the end of the session, each group had created its own e-mentoring product. The final phase was to 'sell' their products. Each group was given the opportunity to present the features of their product, market their product to the other girls and try to convince them to buy it (Figure 5-22).
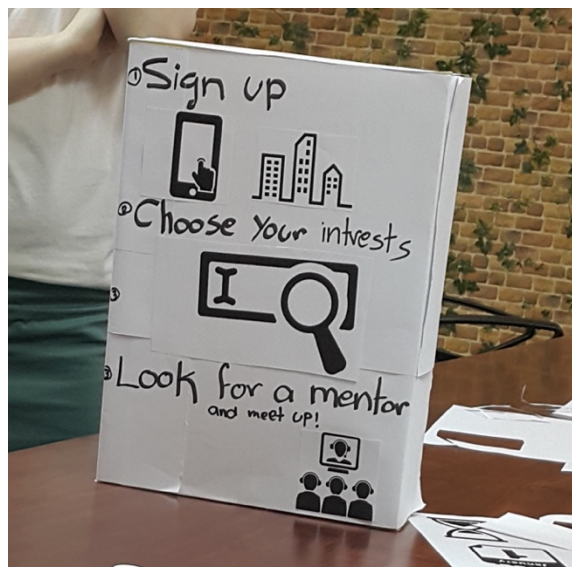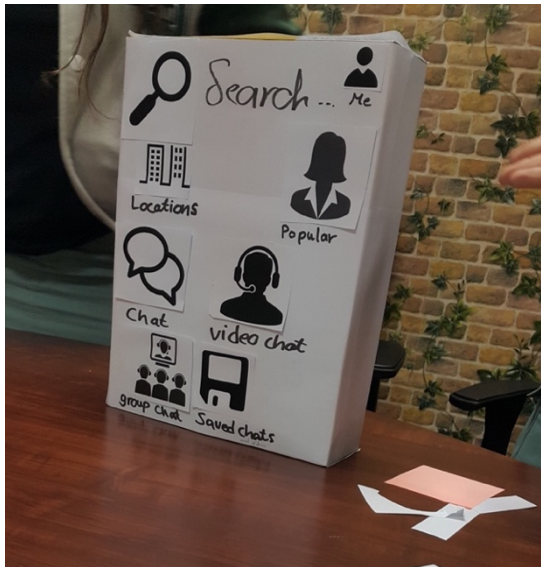
Figure 5-22 Groups' representatives 'selling' their product

5.3.3 *Data from the workshop*

The girls designed their products in English and presented them in Arabic. The designs' descriptions and features listed below are extracted from each group's presentation.

Design#1

Name: world.com (Figure 5-23)

Description: A product that allows you to select the person with a major who you want and to ask whatever you want

Features:
- It is an iPhone app
- You search for mentors in different majors
- When you choose a major, the most popular person in that major will be displayed, then you select the person you are interested in
- Different communication channels: text, video, audio
- You can see their location
- You can save chat and video to benefit other people. If you ask a question that they never thought about, they will benefit from your question and answer; this could reduce the number of meetings with mentors
- You can choose whether you want your session to be public for everyone or not
- Every month, we have a group chat with one of our popular professionals

- Unlimited support; you can log in any time, you can connect with any mentor, any major, any number of times

Requirements:
- Age: above 17
- Create an account
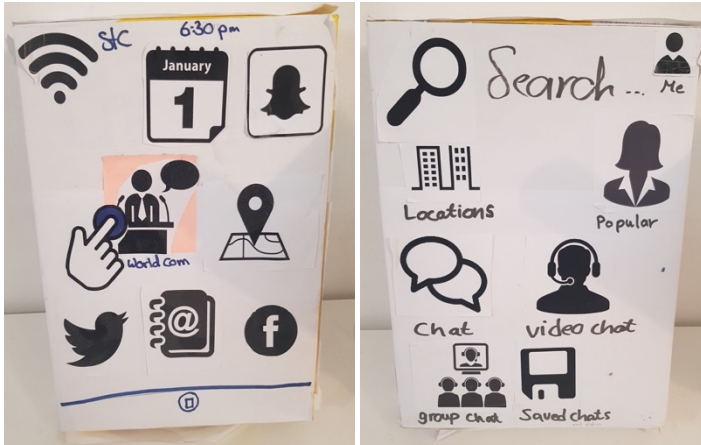
Figure 5-23 world.com design

Design#2

Name: Mentor Me (Figure 5-24)

Tagline: Meet your future

Features:
- It is a mobile application
- Each mentor has a profile
- Communication methods: text, audio, video or face to face
- Our app is developed by an organisation that has a centre where the mentor and mentee can meet up
- You can have as many mentors as you want
- Ratings are available for both mentors and mentees; this will help mentors to accept your request or not and will help girls to choose the most helpful mentors
- Each girl has a progress page including who she has talked to and for how many sessions, what achievements she accomplished and which university or major she enrolled in; this will be public for everyone to see.
- Each mentor can set up a group meeting with many girls; live stream
- The first three months are free of charge, then a fee is set for each session.
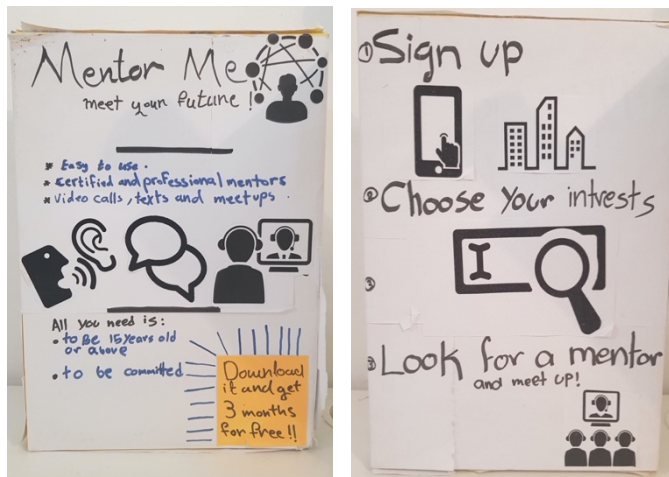
Figure 5-24 Mentor Me design

Design#3

Name: Know Your Major (Figure 5-25)

Tagline: Brighten your future

Features:

- An app with one-time payment of $20

- Scheduling meetings

- Communication method: chat

- No restriction on time; you can log in at any time

- All meetings are one to one

- Live sessions are one mentor with many girls

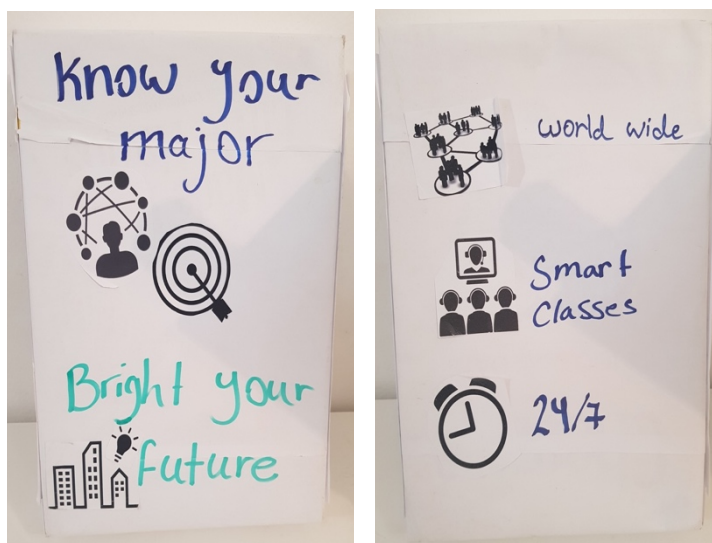- Gain points by interacting with mentors and you will be rewarded with gift vouchers

Figure 5-25 Know Your Major design

5.3.4 *Online survey*

At the end of the workshop, participants were asked to complete an online survey at home (with the help and knowledge of their parents), which was the same survey as used in Study 2. It included demographic data (their ages, plus the ages, education levels and professions of their parents) and their access to female role models.

5.4   Findings and Analysis of Study 2 and Study 3

5.4.1 *Online survey*

Table 5-2 presents the demographics of the parents from Study 2 and Study 3. For Study 2, the table shows that 21 out of 30 mothers' highest level of education was high school, while 4 were illiterate. Even though 5 mothers had a bachelor's degree, none had proceeded further. Comparing fathers' and mothers' education, it is obvious that the fathers had higher education levels. Looking at the parents' field of study and job, of the 5 mothers who had a bachelor's degree only one had studied a STEM field (science) and she worked as a teacher. On the other hand, 11 fathers had at least a bachelor's degree and 7 had studied a STEM field: science (3), technology (2) or engineering (2), and one had a PhD in computer science. Out of 30 participants in Study 2, 13 answered "no" to a question about their siblings: "Have all your siblings who are above 18 obtained or are they currently studying a bachelor's degree?".

Table 5-2 Demographics of parents from Study 2 and Study 3

		Study 2		Study 3	
		Fathers	Mothers	Fathers	Mothers
Age					
	30-45	5	10	–	4
	46-60	18	19	6	6
	61 or older	4	1	4	–
	deceased	3	–	–	–
Level of education					
	Illiterate	3	4	–	–
	High school	16	21	–	1
	Bachelor's degree	9	5	5	7
	Master's degree	1	–	4	2
	Doctoral degree	1	–	1	–
Major					
	Science	3	1	–	1
	Technology	2	–	–	–
	Engineering	3	–	2	–
	Math	–	–	–	–
	Other	22	29	8	9

In comparison, 10 out of the 15 participants completed the survey in Study 3 (Table 5-2) and the results show that participants in this study were of a higher socioeconomic status and level of parental educational background, with almost all parents having at least a bachelor's degree (except for one who had a high school certificate). One mother had a science degree and was a teacher in a school, while 2 fathers had degrees in engineering. All participants answered "yes" to the question about their siblings: "Have all your siblings who are above 18 obtained or are they currently studying a bachelor's degree?" except for one participant.

Most of the participants (80% of Study 2 and 60% of Study 3) expressed the need for help or guidance regarding their studies and career choices (Figure 5-26) and more than half of the participants (56% of Study 2 and 60% of Study 3) indicated that they did not have a female role model in their life (Figure 5-27). More than half of the participants (57% of Study 2 and 60% of Study 3) indicated that they did not have a clear understanding of career options and opportunities related to their major (Figure 5-28).
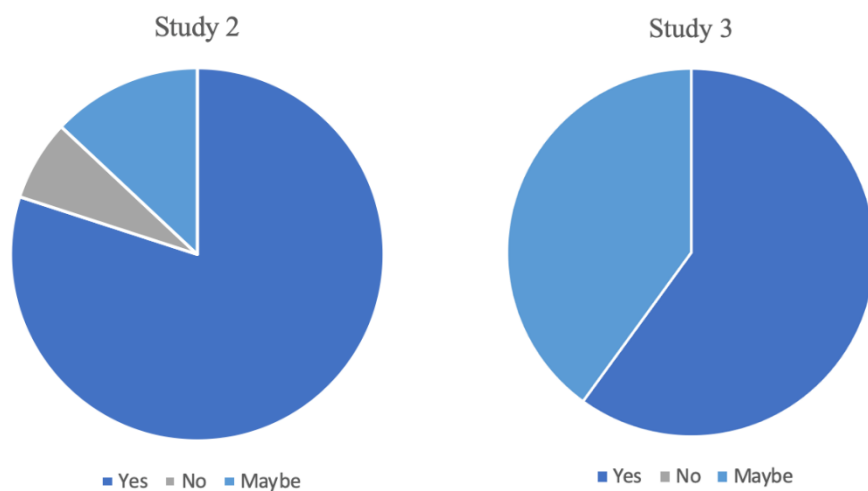
Figure 5-26 Answers to the question: "Do you sometimes feel the need to talk to someone regarding your study or future career?"
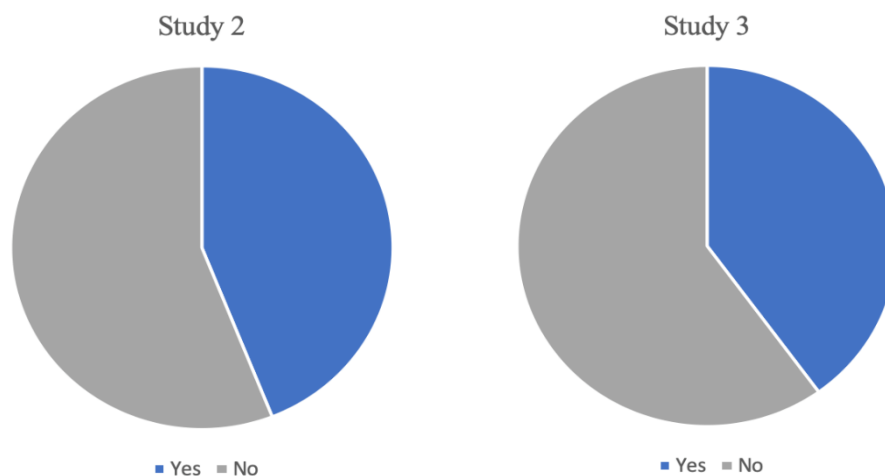
Figure 5-27 Answers to the question: "Do you have a female role model in your life?"
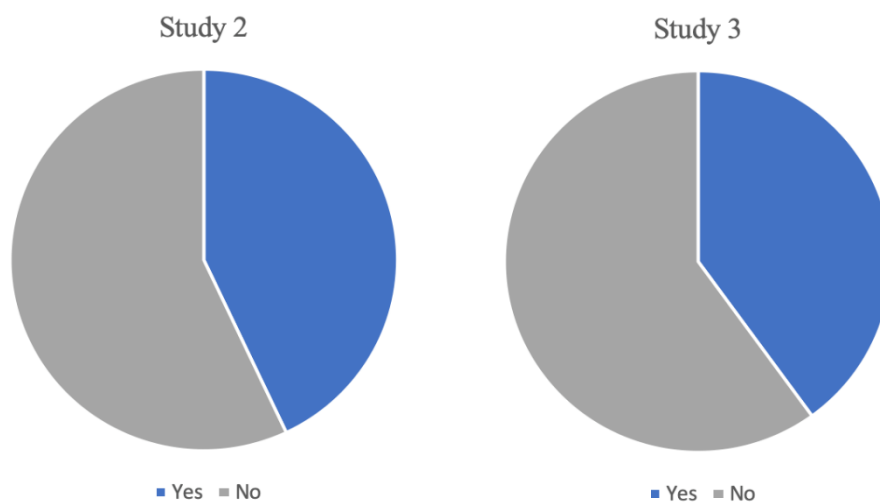
Figure 5-28 Answers to the question: "Do you have a clear vision and knowledge about career options available in your field of study?"

5.4.2 *Thematic analysis of discussions and presentations*

The analysis of the data gathered from the discussions and presentations in Studies 2 and 3 identified similarities in the findings of the two studies. Using the inductive approach to thematic analysis (Braun and Clarke, 2006), which is a data-driven methodology where themes originate from the content of the data, I examined the data from Study 2 and identified a number of themes: *the need for mentoring*, *structuring e-mentoring*, *independence & loose connection* and *references to daily used applications.* The themes were then discussed with my supervisors.

For the data from Study 3, I applied deductive thematic analysis (Braun and Clarke, 2006), which is analyst-driven. Study 3 was conducted to validate the findings from Study 2,

so the themes emerging from Study 2 were the basis of the deductive thematic analysis. Throughout the analysis, I was open to the emergence of new themes, but none were found.

Need for mentoring

Participants from both studies who came from different socioeconomic backgrounds emphasised their need for mentoring. In Study 2, the groups in the first workshop (problem statement stories) generally agreed that the main problem faced by the girl in the video was that she needed both informational and moral support, guidance or even a means to establish whether her dream of a career in space science for a woman was possible in Saudi Arabia. The solution that most groups proposed was the connection of young women with professional women in Saudi Arabia through email, messages, audio, video or text chat. Other ideas included the provision of resources, reading materials, training, job advertisements and informational broadcasts about fields and careers by professionals.

Participants in Study 3, coming from a higher socioeconomic background, did not show less interest or need for mentoring. In Study 3, participants during their "selling" presentation were keen to exemplify how their products were important for students their age graduating from school as they would provide continuous support by having a pool of professionals who would provide mentoring to help them plan their futures.

Structuring e-mentoring

Scheduling with mentors

During the two studies, participants set guidelines and built a structure for e-mentoring. They discussed methods of interaction, duration, attachment levels and guidelines to maintain the seriousness of the system such as penalties, ratings and recognition of mentors.

In the bodystorming workshop (Study 2), participants discussed that mentors should be the ones who displayed their schedules and availability, as they would have busy schedules. In meeting invitations, mentees would have to propose the topics that they wanted to discuss, choose the mode of communication based on options the mentor specified and set the length of the session (suggestions ranged over 15–60 minutes).

In Study 3, participants described their method of interaction and how mentees and mentors could communicate in different ways. S3P1 from Design#1 described her design by saying:

> When you choose a major, the popular person in that major will be displayed. Then you select the person whom you have interest in. You can also select the way you want to chat with them (text, video, audio).*

S3P2 from Design#2 explained:

> All majors will be displayed and then you will choose any major you want. All professionals in that major will appear with a profile about her. Then you choose the meeting type text, audio, video, or face to face.*

Live sessions

Another feature that was common between the designs was the ability to broadcast mentoring sessions to members of the community in what they called "live sessions". In Study 2, live mentoring sessions were suggested in some form by the participants. In the bodystorming workshop, live sessions were thought of as a way to help shy attendees who would find it hard to ask questions. It would also give them the ability to easily disconnect from the session without embarrassment; as S2P9 remarked: "If I did not like what she says or the way she thinks, I can disconnect from the session without disturbing her"*. Questions and discussions that occurred in a live session might enlighten them with thoughts and questions that they had not thought of earlier. In the prototyping workshop, Group#2 and Group#3 illustrated live session icons in their sketches (Figure 5-19, Figure 5-20), which they described as a session set up by a mentor and broadcast to her "followers" (i.e. mentees). S2P10 mentioned during her prototype presentation: "The notifications section over here shows all notifications for scheduled meetings and live sessions by mentors who you follow"*.

Additionally, in Study 3 the designs also included a feature that allowed a mentor to host a group mentoring session (occasionally). S3P2 explained: "Mentors can set up a group meeting with many users like in Instagram's Live feature"* and S3P1 (from a different group) remarked: "Every month, a group chat is hosted by one of our popular professionals"*.

Sharing

Sharing on social media, sharing achievements and sharing sessions were topics raised by participants in both studies. In the first workshop of Study 2, Group#2 and Group#3 talked about how to use social media to share knowledge and gain visibility for their app. In the bodystorming workshop of Study 2, sharing achievements by mentees on social media would help in appreciating mentors and sharing the benefits of mentoring. There was a widely held belief that sharing sessions could reduce the number of meetings with mentors, because many discussions and questions would then be available for others to browse and benefit from. A

mentor could share the most frequent questions publicly on her profile page, which might answer some questions without the need to schedule a session:

> I could broadcast about the mentor through my social media accounts to my friends.* – S2P11

> When I meet a friend who faces the same issues I face, I could tell her how the program helped me and that she can look for her answers there.* – S2P12

In Study 3, Design#1 (world.com) included the ability to save your chat or video session with your mentor. They believed that this would help other members and reduce the number of meetings scheduled. S3P1 explained:

> You can save chat and video to benefit other people. If you ask a question that they never thought about, they will benefit from your question and answer. This could reduce the number of meetings with mentors. You can choose whether you want your session to be public for everyone or not.*

In Design#2 (Mentor Me), they presented having a progress page for each mentee which would be public to share with other users, to encourage them to schedule mentoring sessions. S3P2 elaborated on sharing:

> Each girl has a progress page including who she talked to and for how many sessions, what achievements did she have, which university or major did she enrol in. It will be public for everyone to see.*

Serious engagement

Participants in both studies proposed penalties and solutions to promote "serious" engagement by mentees. In Study 2, for example, in the bodystorming workshop, one proposal that received wide support was that a mentee who did not show up for three meetings would be banned from scheduling a meeting for one month or be able to schedule on a waitlist only. Financial penalties for missing mentoring sessions (with the mentor having the power to waive the penalty) were also proposed, as was a start-up fee to use such a service:

> We can charge a small amount for participation to avoid the problem of scheduling meetings and not showing up.* – S2P6

Two groups in Study 3 discussed the importance of the voluntary time contribution made by the mentors and design#2 (Mentor Me) proposed a small fee for each mentoring session:

> When you register, the first 3 months are free of charge, then you pay for each session.* – S3P2

Design#3 (Know Your Major) suggested a one-time start-up fee for joining the program. The inclusion of fees was intended to ensure the "seriousness" of the mentees, to encourage them to be more committed to their meetings and to help with the administrative support of the services the girls had designed:

There is a one-time payment of $20 so you can use the app.* – S3P3

Ratings and reviews

Moreover, there was also significant discussion about how to recognise mentors' contributions in Study 2. Some suggested that mentors could be evaluated after each session, leading to "mentor of the month" status for the highest rated. Additionally, it was suggested that mentees could write about how their mentors had contributed to their achievements and share them on their profiles or social media. Mentees could also invite other professionals to join and become mentors. S2P12 said: "Mentees could invite potential mentors to join the program"*.

Ratings and reviews were also proposed in the designs of Study 3. Design#2 (Mentor Me) included ratings and reviews after each session, with the mentee rating her mentor and vice versa. From the mentors' side, it was suggested that this would help them to decide whether to accept a request for a meeting from a mentee, and from the mentees' perspective, it would help them to choose the most helpful mentors:

After each session, you can rate your mentor and she will rate you as well. This will help other mentors if they would accept your request or not and will help girls to choose the most helpful mentors.* – S3P2

Design#3 (Know Your Major) demonstrated that a mentee got points by interacting with mentors. These points qualified her for a gift voucher:

Girls will have points for interacting with mentors, and those who have more points will get gift vouchers from our sponsor. As a way to motivate girls.* – S3P3

S3P4 from Design#2 after the presentation of the third and final product suggested combining the rating idea from their design with the voucher idea from the third design. She explained: "or when you have good ratings from your mentors, you get a gift voucher"*.

Independent and loose connection

It was common in both studies that participants wanted to initiate the mentoring relationship, that is, they would select their mentors rather than being matched up with them. Also, they were demanding flexible, uncommitted relationships. In Study 2, participants in the

bodystorming workshop stressed the importance of first-time meetings being non-committal and not exceed 15 minutes, and these would be used as the basis for a mentee to decide to enter into a mentoring relationship or not:

> Sometimes you do not feel connected with someone and you can know that from the first meeting. You don't want to be committed to a person you don't feel comfortable with.* – S2P4

Where a mentee wanted to progress beyond an initial meeting, another meeting could be scheduled or a subscription established for weekly or monthly meetings. Participants were also clear that they did not want to be limited to one mentor and should be allowed to choose one or more mentors. They stressed the advantages of being in contact with more than one mentor, being connected to more people, learning about new ideas and different perspectives, and getting more than one opinion or answer to a question, and that this would increase knowledge about available careers for women in Saudi Arabia:

> I can get more than one opinion/answer for my questions.* – S2P10

> I want to know about more careers.* – S2P13

All designs from Study 3 shared the idea of browsing mentors and contacting as many as you wanted. Flexibility and freedom in contacting and communicating with mentors were among the significant features. One group mentioned "not being committed to one mentor"* as one of their special features. Another group described their design by saying: "You can log in any time, you can connect with any mentor, any major, any number of times"*.

References to daily used apps

Familiar concepts such as followers, following, timelines, likes, live sessions, popularity and ratings were common among the two studies. In Study 2, participants in the bodystorming session were referring to social media when talking about "live sessions" and one participant suggested "live sessions like the ones we view on Instagram"*. When the discussion about ratings was raised, one participant explained by saying: "Just like we rate Uber drivers"*. The prototyping workshop in Study 2 led to a number of designs that closely resembled social media apps and platforms, and references to these were made when participants were presenting their designs. For example, when presenting the interface elements of her group's design, one participant said: "These circles over here are for the ongoing live sessions, like the ones we see on Snapchat and Instagram"* (Figure 5-19).

Another group from Study 3 described that they would feature "popular" mentors in live sessions: "Every month, we have a group chat with one of our popular professionals"* (Figure 5-23).

5.5 Discussion

In this work, it was readily apparent from the two studies presented here and the previous pilot study that the participating young women and teenagers were seeking more flexible and less committed e-mentoring relationships than those provided by structured e-mentoring. In this section, I examine these issues further and discuss how the unique traits of the study population (Generation Z) had a major influence on the outcomes of this research. The findings suggest a need to significantly change the format of e-mentoring, by applying co-design activities as a first step in e-mentoring and considering approaches to designing e-mentoring using existing technologies and in ways better fitted to these mentees' lifestyles.

5.5.1 *Cultural dimensions of the target age group*

The privacy requirements of the female participants in the Saudi context, the selection of the mode of communication and the parental involvement were cultural factors that were initially thought of as requirements for designing e-mentoring for females in Saudi Arabia. However, the participants in this study did not show concern about these cultural factors. The findings in this study appear to be affected less by cultural norms and more affected by the cultural dimensions of the target age group. That is, many of the changes in the mode and format of e-mentoring that the participants identified are likely attributable to the communication preferences and online practices of the of the age group of the participants.

The target age group of this research have not known a world without the internet (Bencsik and Machova, 2016; Garrick et al., 2017), which makes them distinct, as no other generation has had access to the internet in their early years (Bencsik et al., 2016; Garrick et al., 2017). Even though the literature on their generation is relatively limited (Shatto and Erwin, 2017), their identified characteristics (compared to previous generations) include being: smarter, (more) independent, practical, unafraid of change, able to multitask, able to process information more quickly, technologically savvy, always online and dependent on the internet as their main source of information (Bencsik et al., 2016; Igel and Urquhart, 2012; Ivanova and Ivanova, 2009). However, they have also been characterised as impatient, not team players and with short attention spans (Bencsik et al., 2016; Erjongmanee, 2017; Igel and Urquhart, 2012; Ivanova and Ivanova, 2009).

The findings show some correspondence with these traits. For example, one theme that emerged from the analysis of Studies 2 and 3 was *independence*. Participants desired flexible and uncommitted relationships, the ability to connect with more than one mentor and the power to initiate mentoring relationships themselves. On a number of occasions in Study

2, during the bodystorming workshop, participants mentioned terms and phrases such as: "15-min meetings"* and "not committed to one mentor"*, and during the session in Study 3, "you can connect with any mentor, any major, any number of times"*. In some respects, it could be considered that they did not have the patience required to develop a committed relationship or were too independent to require continuous relationships. It is also possible that participants considered mentors to be a live 'source of information' on the internet. Another possible consideration is that this younger age group of Saudi females were demanding control and power in their society. As discussed earlier in Chapter 1, while gender segregation between men and women in the Saudi culture has weakened the voice of Saudi females, it has been discussed that the online space has constructed a place for Saudi women to strengthen their visibility and make their voice heard (Al Lily, 2011; Al-Saggaf, 2011; Guta and Karolak, 2015).

As the traits of this age group are different, research studies are actively investigating how to address this new generation in different contexts such as schools (Igel and Urquhart, 2012), universities (Ivanova and Ivanova, 2009; Shatto and Erwin, 2017), workplaces (Bencsik et al., 2016; Ozkan and Solmaz, 2015) and the retail industry (Priporas et al., 2017). Likewise, there is a space for redesigning e-mentoring to better meet the needs of this new generation.

5.5.2 *Co-design e-mentoring*

The findings suggest a need to shift away from traditional structured e-mentoring models and platforms. Previous literature on e-mentoring has insisted that frequent regular meetings between mentors and mentees and the building of a mentoring relationship are key elements in the structure of e-mentoring programs (Bierema and Merriam, 2002; Single and Muller 2001). On the other hand, e-mentoring programs still face the problems of mentee dropout and the early termination of programs (Rhodes et al., 2006; Stoeger et al., 2013; Wallis et al., 2015), including in my own study in Chapter 4 (Study 1). These problems could be related to the lack of development of e-mentoring approaches in comparison to the development of technologies and changes in generations. Another aspect worth considering is that previous e-mentoring literature has dealt with e-mentoring as one approach for diverse populations and contexts.

I argue that the inclusion of mentees in the design process, rather than them joining a pre-structured e-mentoring program, might be one solution to this problem. Participants in this study were able to build a structure for e-mentoring by discussing regular elements in e-mentoring designs: relationship level, duration and means of communication. In addition, they

did not overlook elements that have been identified as challenges in maintaining the sustainability of mentoring programs, for example, recognising mentors' voluntary contributions (DuBois et al., 2011) and the recruitment of mentors by youth (Rhodes and Lowe, 2008). Designs in these studies developed a structure for sustainability by appreciating mentors (i.e. "mentor of the month"), mentee recruitment of mentors and setting penalties and solutions to maintain the seriousness of e-mentoring.

The holistic manner of thinking about e-mentoring exhibited by participants in the studies demonstrates a high level of maturity and the ability to build complete e-mentoring designs. Therefore, applying co-design activities in e-mentoring as the first phase of the process would provide those young women and teenagers with agency and power in their own e-mentoring experiences.

5.5.3   *Un-platforming E-mentoring*

Participant references to social media and audio/video communication technologies were made on many occasions in the studies. Indeed, it is logical and practical to consider how e-mentoring might reach out and connect to girls in the digital space that they already occupy, rather than imposing a new space or platform on them. Previous literature on e-mentoring programs, which provided various communication methods for contact with mentors, showed that mentees mainly used communication methods that they were familiar with and used frequently (Norodien-Fataar, 2012; Todd et al., 2016). I refer to this process of using existing technologies and social media to realise new and more accessible opportunities for e-mentoring as *un-platforming e-mentoring*. Un-platformed e-mentoring creates a space for developing frameworks on top of existing technologies to scaffold/support the recruitment of mentors and mentees. It also permits more familiar processes (for young people) to initiate and build mentoring relationships, to create and distribute content, and to control visibility. Previous work on biculturalism (Vacca, 2017) and cyberbullying (Ashktorab and Vitak, 2016) has presented designs by teenagers that mainly extended current social media platforms or were built on them. Similar to my consideration of un-platforming, Vacca (2017) suggested that the process of co-design should focus on developing plugins and extensions, rather than standalone designs. Ashktorab and Vitak (2016) also suggested that future work should take advantage of existing technologies to implement the proposed solutions designed by teenagers. The references to daily used social media such as Snapchat and Instagram in Study 2 (with young women) and Study 3 (with teenagers) provide evidence that the un-platforming of e-mentoring has wide appeal for this generation.

The notion of un-platforming raises the question of what the trade-offs are between a dedicated e-mentoring platform and the use of existing social networks. While trade-offs in the design of programs have not been discussed in the e-mentoring context (O'Neill et al., 2011), they have been discussed in other contexts such as online learning. Celina et al. (2018) discussed the trade-offs between using a platform-based course and a loosely coupled media course (equivalent to my un-platformed approach) in online learning. While the platform-based course was found to be helpful in centralising and focusing on learning objectives and tasks, the less structured learning environment (using loosely coupled media) was shown to create relationships that lasted beyond the course and promoted more independent learning and problem-solving skills. This meant that loosely coupled approaches worked better for those focusing on building social capital, while the platform-based approach worked better for those focusing on knowledge acquisition. Similarly, e-mentoring should not be thought of as a one-size-fits-all process.

Inevitably, trade-offs between platformed and un-platformed approaches to e-mentoring are also highly context-dependent in that they vary according to the nature of the participants, the modes and levels of engagement anticipated, and the goals of the e-mentoring program. For example, designing an e-mentoring program for young people with psychological or health problems who need continuous observation and follow-up meetings is very different from designing STEM e-mentoring for young women and girls. Young people with health problems are unlikely to be comfortable discussing such issues with their mentors using publicly accessible (i.e. un-platformed) social media channels and should generally be discouraged from doing so. They would be more appropriately mentored through a secure and closed digital platform. On the other hand, un-platformed e-mentoring has the potential to positively impact on mentees' levels of interaction and engagement. Given that social media is part of their everyday internet activity, it could be the means by which they build lasting relationships with mentors, as was found by Celina et al. (2018).

These aspects merit further investigation, given that most accounts of e-mentoring programs report challenges such as premature termination of relationships between mentors and mentees (Rhodes et al. 2006), program dropout (Wallis et al., 2015) and inactive mentors (Lenear, 2007). While giving up some centralised control (un-platforming) limits the scope of processes such as content moderation, the utilisation of mainstream services and technologies leverages the high standards of usability, security and privacy that come with systems and implementations which operate on a global scale. Furthermore, un-platformed e-mentoring leverages mentees' and mentors' everyday social media literacy, in terms of their ability to

express themselves, their understanding of who has access to messages and posts, and how data generated is stored and used.

5.6 Summary

In this chapter, I have described how I applied co-design methods to gather and capture the requirements of the targeted population. The findings of the two studies were affected less by cultural norms and more by the traits of the participants' generation. The co-design workshops pointed to a need to shift the design of e-mentoring models to incorporate co-design in order to increase engagement and give a voice to young women. The findings indicated that young women and teenagers were seeking mentoring relationships that were more flexible, with less commitment and more integrated with their everyday lifestyles and use of mainstream online technologies. As a result, I proposed the un-platforming of e-mentoring and the development of frameworks that build on existing technologies to facilitate e-mentoring.

Chapter 6 The Design of *Qudwa*

6.1 Introduction

This chapter introduces the design requirements and system design of *Qudwa*, an un-platformed STEM e-mentoring system designed to facilitate communication between female Saudi professional mentors and young female mentees. The findings of my previous studies indicated that a shift was needed in the approach to providing e-mentoring for young women. This design responds to the findings from Studies 1, 2 and 3. In Chapter 4, the results of Study 1 suggested further investigation into the requirements of e-mentoring for young women and teenagers in the Saudi context. In Chapter 5, the findings of Study 2 and 3 pointed out that the participants (young women and teenagers) were looking for a different form of relationship. In 2002, Bierema and Merriam (2002, p. 223) discussed the future of e-mentoring: "The possibilities for e-mentoring are as endless as the Internet. The extent to which this medium will be used for mentoring is unknown as are the best ways to maximize the nature of this medium for this purpose".

Qudwa has been designed based on the findings of the studies described in Chapter 4 and Chapter 5 and the lessons learned from previous work on structured e-mentoring. My results indicated that young women and teenagers preferred less committed and more flexible e-mentoring relationships. They also desired to choose their own mentors and to communicate in a way that was more integrated with their daily internet activity. Even though previous work on e-mentoring used social networking platforms as their media, they did not provide participants with control over their relationships. These programs were structured in terms of the researchers choosing the medium of communication, the frequency of contact and the matches beforehand. *Qudwa* aims to empower both mentees and mentors by giving them more freedom in choice and flexibility. This chapter begins by describing the design requirements followed in the system design of *Qudwa*.

6.2 Requirements for Design

From working on the previously described studies (Studies 1, 2 and 3) and with the lessons learned from previous work on e-mentoring, I was able to understand the needs and requirements for facilitating STEM e-mentoring relationships for young women and teenagers. Four design requirements emerged from the conducted work: 1) flexibility and control; 2) visibility; 3) integration of e-mentoring with daily internet activity; and 4) a trusted connection between mentors and mentees (Table 6-1).

Table 6-1 Summary of *Qudwa*'s design requirements

Design requirements	
RQ1 Flexibility and control	
	RQ1.1 Mentee-initiated relationship
	RQ1.2 Flexibility and control in the e-mentoring relationship
	RQ1.3 Flexibility and control in choosing the communication channel
RQ2 Visibility	
RQ3 Integration of e-mentoring with daily internet activity	
RQ4 A trusted connection	

6.2.1 *RQ1 – Flexibility and control*

The findings showed that the participants desired more flexibility, more control and less commitment in their relationships. This means that they wanted control in choosing who, how, how many mentors and for how long they would contact their mentors. The results of the conducted work showed that participants described an e-mentoring relationship initiated by them. The findings identified the need for a design that can support e-mentoring without requiring the girls to commit to a mentor or forcing them to contact their mentors regularly. It should allow contacting as many mentors as needed and only when needed. Another aspect that showed their desire for control is that participants requested to be able to recommend professionals to be mentors.

As mentioned earlier, e-mentoring programs have faced the problems of mentee dropout and the early termination of programs (Rhodes et al., 2006; Wallis et al., 2015), including my own study (Study 1). Previous work on e-mentoring has demonstrated how participants made changes in their e-mentoring relationships, whether a change in the means of communication or in the structure of the e-mentoring relationship.

E-mentoring programs that provided more than one communication method showed that mentees mainly used communication methods that they were acquainted with and used frequently (Norodien-Fataar, 2012; Todd et al., 2016). In the study of Norodien-Fataar (2012), the mentors, who were undergraduate students mentoring their peers, were divided into three groups and each group was asked to use a specific method of communication. One group was asked to use an LMS, the second group was asked to use Facebook and the third group was encouraged to use any means of communication. The findings showed that all three groups used Facebook and MXit (which is the largest instant messaging and social

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network in Africa). The reason that participants used Facebook and MXit was that these platforms were more familiar among mentees; they are widely used and the ability to be on the social network "doing your own thing" and contacting your mentor at the same time was a favourable feature. BreakThru (Todd et al., 2016) was a STEM e-mentoring program for secondary and post-secondary students with disabilities that utilised virtual worlds as a means of communication. The study concluded that the use of virtual worlds was insufficient and participants favoured the use of methods that were faster, more accessible and more familiar to them, such as audio calls, SMS text messaging and email.

In other examples, mentors and mentees changed the structure of how their e-mentoring relationship was set by the researchers and developed what suited them best (Stewart and Carpenter 2009). Stewart and Carpenter (2009) designed an e-mentoring program for physical therapists in rural areas. The program was set up with daily emails, weekly chat and monthly video conferencing (iChat). Because participants favoured the use of video conferencing, the form of interaction was changed by the participants after two weeks of the program to video conferencing twice weekly and email used irregularly.

Therefore, three sub-requirements were derived:

- RQ1.1 Mentee-initiated relationship

- RQ1.2 Flexibility and control in the e-mentoring relationship

- RQ1.3 Flexibility and control in choosing the communication channel

6.2.2   *RQ2 – Visibility*

A second design requirement is visibility. Earlier in Chapter 4 I discussed the issue I faced during the recruitment of mentors; it was not because they do not exist, but because of their lack of visibility. The lack of communities and networks for female Saudi professionals made it difficult for me to find them and reach out to them. Findings from the studies showed participants wished to learn about all available professions and opportunities for females in Saudi Arabia by connecting with more than one mentor. Their longing to be connected with many mentors was because they wanted to seize the opportunity of the availability of a group of mentors to learn more from them and get different answers or opinions to the matters they were thinking about.

6.2.3   *RQ3 – Integration of e-mentoring with daily internet activity*

Another design requirement is the integration of e-mentoring with daily internet activity. In

Chapter 5, the participants referenced social media platforms and applications that they used daily in describing how they envisioned their e-mentoring experience. From there the idea of un-platforming e-mentoring and usage of existing platforms has been derived.

Previous work in the literature showed that participants tended to use platforms that they were accustomed to or used regularly. Other articles discussed the use of SNS as a medium for structured e-mentoring (Norodien-Fataar, 2012; Rashid and Rahman, 2014; Ware and Ramos, 2013). Specifically, Facebook was used as an e-mentoring communication method. As mentioned earlier, in the study of Norodien-Fataar (2012), participants used Facebook and MXit because they could contact their mentors/mentees and interact with their social networks. In the study of Ware and Ramos (2013), Facebook was used to provide informational support for first-generation Hispanic college students. They employed Facebook to conduct structured e-mentoring where the mentor posted weekly to the group's wall. The study stated that the benefits of using social media in e-mentoring were the immediacy, constant connectivity and flexibility of such media. Similarly, the findings of Rashid and Rahman (2014) indicated that social media provided an informal, relaxed and flexible atmosphere for structured e-mentoring. All the mentees and mentors were in one Facebook group and the e-mentoring program aimed to enhance the creativity of interior design students. The findings stated the effectiveness of using Facebook as an e-mentoring medium. Mentees felt less stressed and more informal while engaging with their mentors. One mentor explained that students used Facebook constantly for their personal engagements with their friends, which increased their participation in the e-mentoring group. They also stressed the importance of learning the boundaries between personal and professional usage of social media as a medium for e-mentoring. In some cases, the mentees posted comments on their mentor's timeline which caused inconvenience for the mentors.

These examples show how e-mentoring was previously deployed using different social media platforms. While platforms such as Facebook were favoured and frequently used by the participants in these studies, this suggests the use of SNS that are highly used among young women and teenagers in Saudi Arabia.

6.2.4 *RQ4 – Trusted connection*

The final design requirement is a trusted connection between mentors and mentees. The fact that mentoring, in general, is an unfamiliar concept in Saudi Arabia cannot be ignored and, in some cases, participants were thinking of mentoring as a "lecture" or a "course" session. Therefore, this connection is to ensure that mentoring is conducted as it should be and to clear up any misunderstandings. Participants on different occasions in relation to their designs

referred to the presence of a centre or an organisation. This might relate to their need for safety or security when contacting someone who was a stranger to them (a mentor).

6.3 *Qudwa*

6.3.1 *What is Qudwa*

Qudwa قدوة is an Arabic word which means 'role model' or someone you look up to. *Qudwa* is a STEM e-mentoring system for teenagers and young women in Saudi Arabia to be mentored and connected with female Saudi professional mentors. It is designed to give mentees and mentors more flexibility and control in their e-mentoring relationships. *Qudwa* is designed to be embedded in their daily internet activity, instead of pulling them into another space, by using existing social networking platforms. *Qudwa* aims to raise the awareness and visibility of Saudi professional women and their careers, and to encourage girls to engage in different fields of work and to introduce them to the areas of work available to them.

Qudwa is a website built on the concept of the Wizard of Oz (Figure 6-1). The home page presents the pool of mentors in one place. The mentee has the control to search, browse and choose her mentor or mentors. After choosing a mentor, she selects how she would like to be in contact with the mentor. *Qudwa* provides three means of communication: 1) an online meeting via Appear.in; 2) a WhatsApp group led by the mentor; or 3) being introduced to the mentor through social media. All requests submitted by mentees are handled manually by the admin. Then the mentor and the mentee will be in contact. Figure 6-2 describes the mentee's journey in using *Qudwa* and also presents how each step on the user journey meets the design requirements previously found.
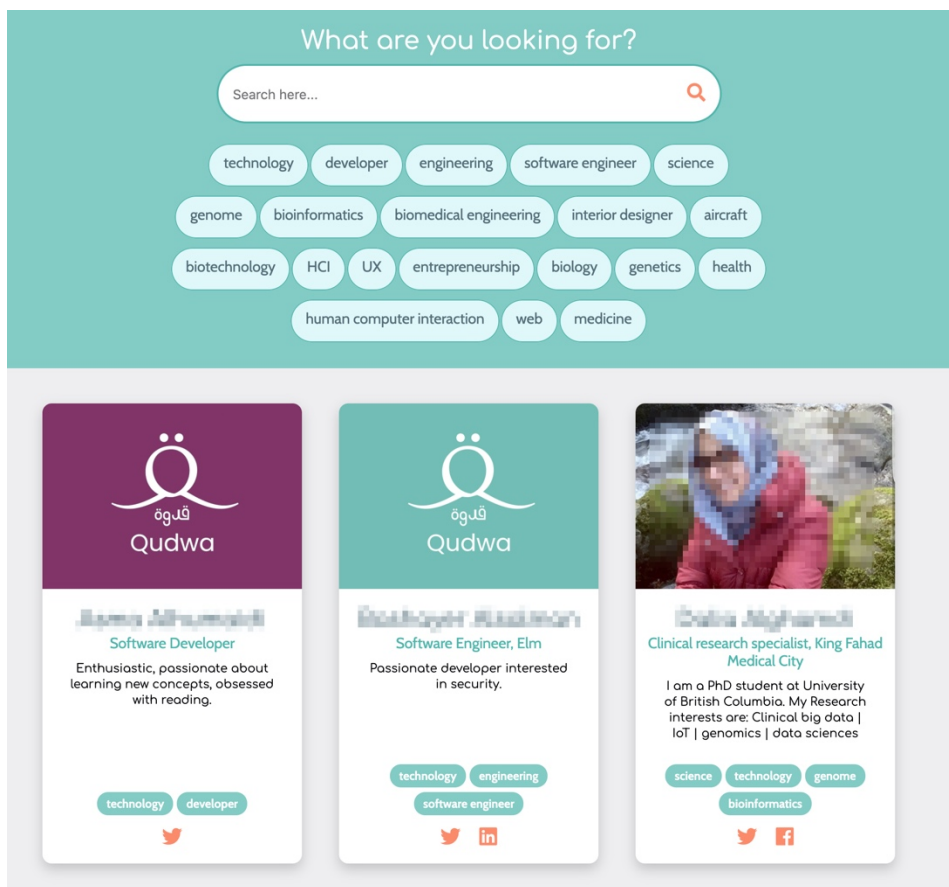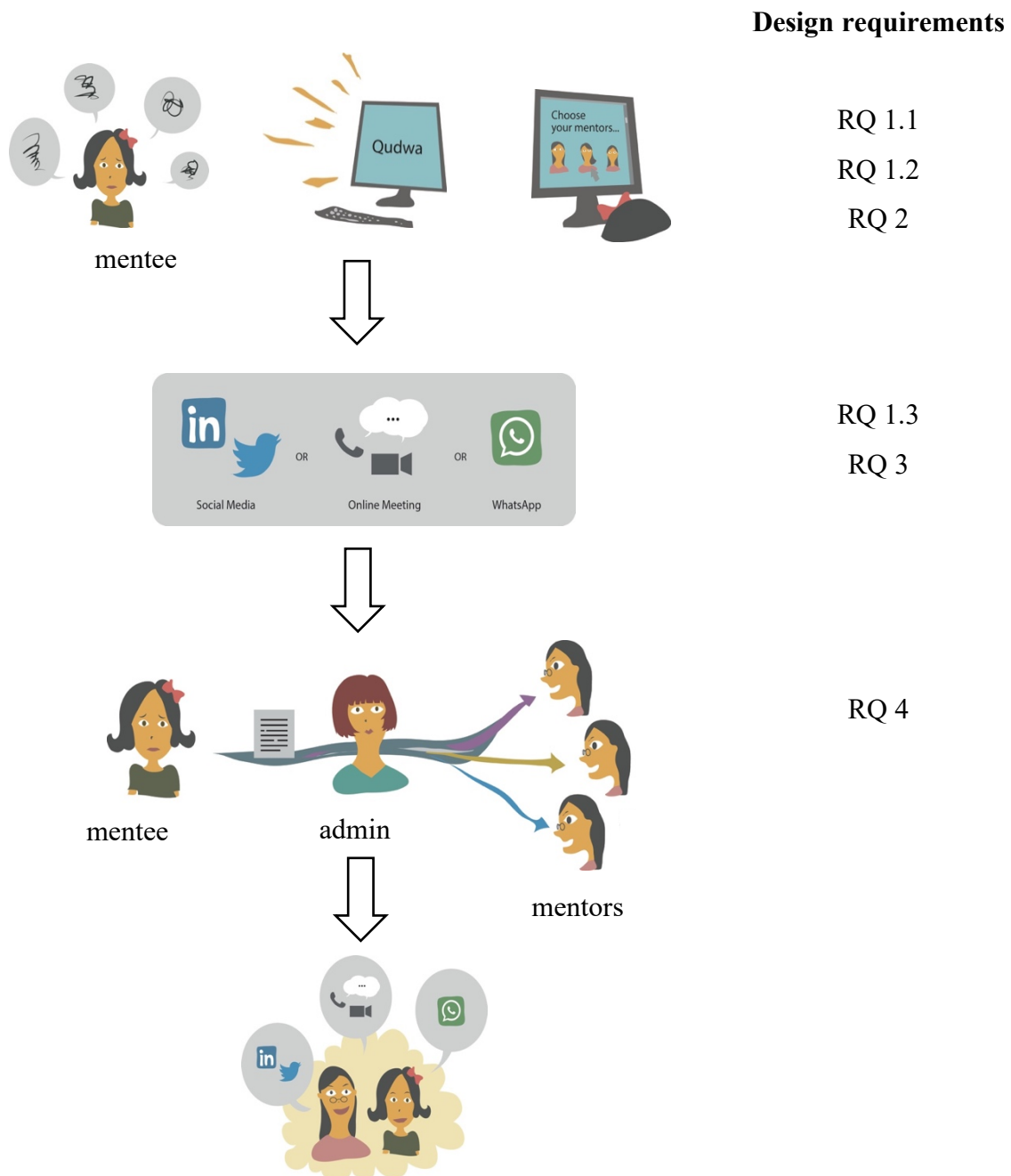
Figure 6-1 Home page of *Qudwa*

Design requirements

RQ 1.1
RQ 1.2
RQ 2

RQ 1.3
RQ 3

RQ 4

Figure 6-2 User journey of *Qudwa* presenting each step and its design requirements

6.3.2 *Meeting the requirements*

RQ1 Flexibility and control

Flexibility and control are given to the mentors and mentees on how, when and for how long they want to contact each other. *Qudwa* provides three channels for communication: 1) an online meeting via Appear.in; 2) a WhatsApp group led by the mentor; or 3) being introduced to the mentor through social media.

Each mentor at the recruitment stage will have control over the methods she wants to be contacted with. All three methods are available for all mentors unless a mentor requests to

eliminate a method. The mentors will provide *Qudwa* with their social media accounts of the platforms of their choice and their choice for audio calls only or video calls.

On the other hand, the e-mentoring relationship is initiated by the mentees. The mentee will browse and choose her mentor (RQ1.1). The mentee will have the choice as to which mentor to contact. *Qudwa* does not request a specific frequency of contact between the mentor and the mentee, so a mentee can have one session with her mentor or several sessions, based on her needs and preferences (RQ1.2). She also has the freedom to choose which method of communication suits her (RQ1.3). These choices are not fixed. While she might prefer to contact one mentor through an online meeting, she can communicate with another mentor through WhatsApp.

RQ2 Visibility

Qudwa presents all available mentors on the website with their information, education and previous and current workplaces and positions. The pilot study in Chapter 4 showed that displaying mentors' profiles had a positive effect on mentees' awareness of available opportunities for women in Saudi Arabia. In addition, Savoy (2013) in her study stated that the most favoured aspect for participants in her STEM e-mentoring program was knowing and reading the mentors' profiles. Participants indicated that reading the biographies was encouraging and raised their awareness of the opportunities to be a female professional in a STEM field (Savoy, 2013). Therefore, by presenting mentors' profiles *Qudwa* intends to create visibility for the mentors among their peers and among mentees, and raise awareness of current and available opportunities for females in Saudi Arabia.

RQ3 Integration with daily internet activity

According to the General Authority for Statistics (General Authority for Statistics, 2018), 72.54% of people in Saudi Arabia access the internet to participate in social media platforms. Therefore, *Qudwa* facilitates the use of existing social media platforms and the high usage of such platforms to serve e-mentoring. *Qudwa* provides three main communication methods: 1) requesting an online meeting; 2) through WhatsApp; and 3) introduction through social media. Online meetings use audio or video calls depending on the participants' choice. *Qudwa* uses Appear.in (now called Whereby). This platform does not require a sign-in process or sharing usernames, which eases the process of communicating. For each scheduled session, a new link is created and shared with the mentor and mentee. Only those who have the link can join the session. Shared links can be used on mobile or desktop/laptop devices. Because WhatsApp is the most widely used social networking platform in Saudi Arabia

(Ministry of Communications and Information Technology, 2016), it was selected as the text-based communication method. WhatsApp can be used for one-to-one or one-to-many communication. The final method gives the mentee the choice of contacting the mentor through other social media platforms (provided by the mentor). If requested, the admin will introduce her to the mentor to ease the communication between them or she can contact her directly.

RQ4 Trusted connection

The trusted connection or human factor is the admin (me). All connection requests sent by mentees are received by the admin. The admin filters the requests and proceeds with them. The unautomated system is based on the Wizard of Oz method, where parts of the system behaviour are simulated by a human 'wizard' – the admin (Salber and Coutaz, 1993). In *Qudwa* the admin manages all connection requests. The Wizard of Oz is an experimental evaluation method (Salber and Coutaz, 1993).

The presence of a human in handling the system is required for evaluation and safeguarding purposes. Since e-mentoring and the system itself are novel in the context, the admin is needed for testing the initial implementation of the system, observing and collecting data. The wizard in this system is also intended to provide safety and safeguarding for the participants. The admin makes sure that connections are made, solves any problems faced by the participants and safeguards them, that is, she prevents mentors from being contacted by fake or fraudulent people who claim to be young women, for example. The admin also makes sure that mentees are connected to the right mentors and are not abused or neglected by the mentors.

6.3.3 *Design of Qudwa*

Home page

The home page of *Qudwa* shows all the mentors in one page (Figure 6-1). There are two language versions of *Qudwa*: English and Arabic. At the top of the page, there is a search bar and tags to ease the search for mentors. For each mentor on the home page, it shows the mentor's profile picture, brief biography, tags for related subjects and social media accounts (RQ2). Tags are used to ease the search process and to educate the mentees about different fields. At the bottom of the page there are two links, one for helping mentees if needed and one for recommending mentors (RQ1) (Figure 6-3).
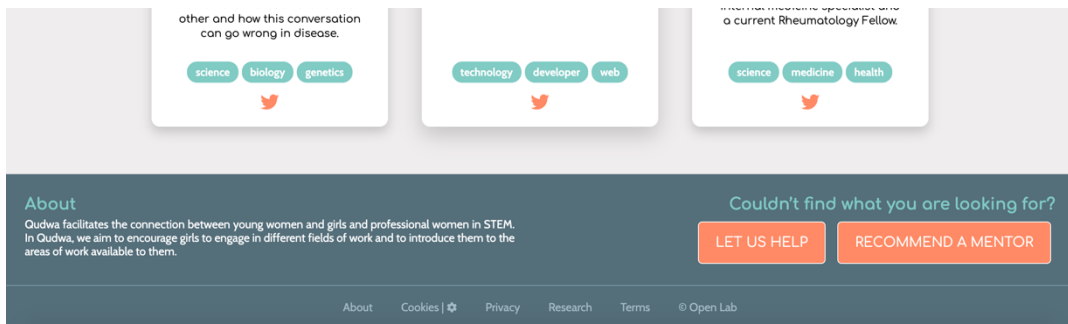
Figure 6-3 Bottom of the home page

Mentor profile

On the mentor's profile page, a more detailed biography is presented with information about her education and work experience. In addition, each mentor shares topics that she can help with such as job applications and university applications. Mentors share their personal interests. At the top the tags are shown, while at the bottom the social media profiles of that mentor are shared. The ways to connect with a mentor are on the left of the page (RQ1.3 & RQ3) (Figure 6-4). Figure 6-5 shows the methods supported by the system for connecting with a mentor. Each method is explained through a help message (Figure 6-5).
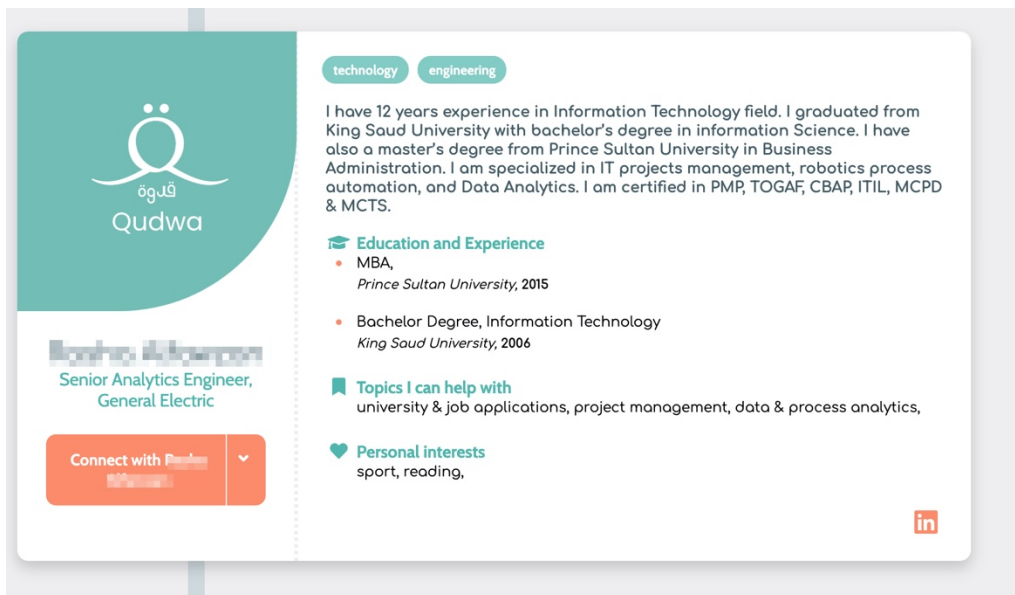
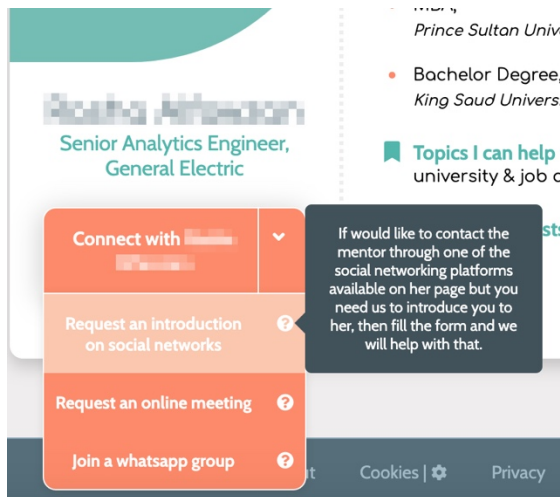

Figure 6-4 Profile page of a mentor

Figure 6-5 Dropdown menu shows how to connect with a mentor

Request form

When a mentee chooses to connect with a mentor, she fills in a form (RQ1.1, RQ1.2, RQ1.3 & RQ3), providing her full name, email address, mobile number, a brief introduction about herself and the topic she wants to talk about with the mentor (Figure 6-6). Each form is slightly different than the others depending on which connection method was selected. If the mentee chooses to be connected through social media, the form asks her to choose which platform she wants to be connected on and her username on that platform (Figure 6-7). With online meetings, the form asks her to specify whether she prefers audio or video calls (Figure 6-8).

Figure 6-6 Request form for the WhatsApp group connection method

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Figure 6-7 Request form for the social network connection method
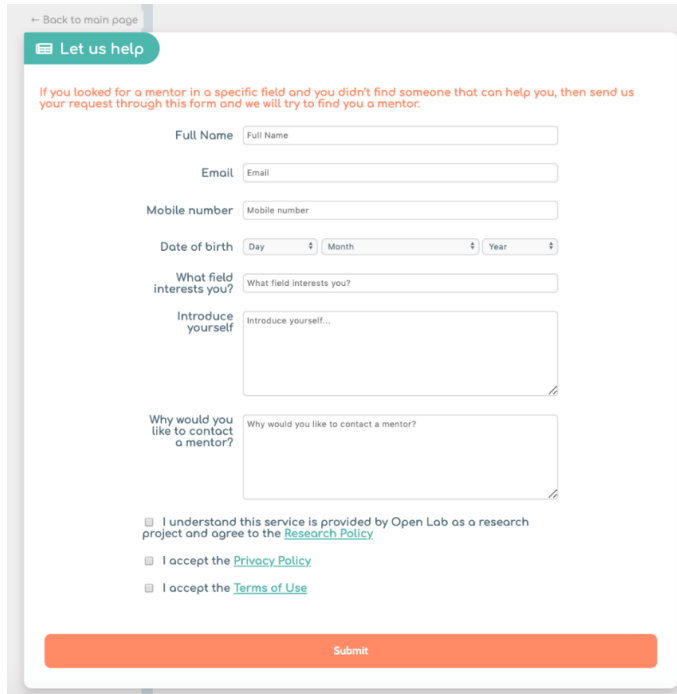
Figure 6-8 Request form for the online meeting connection method

Let us help

This page helps a mentee if she has not found a mentor in a specific field or needs guidance. A form is displayed which is similar to the request forms previously shown but has a section for the field of interest (Figure 6-9).

Figure 6-9 Let us help form

Recommend a mentor

This page is for recommending mentors. Anyone can recommend a female professional to be a mentor on *Qudwa*. The page shows a form to be filled in with the mentor's name and ways to contact her (Figure 6-10).

Figure 6-10 Recommend a mentor form

Admin page

The admin page is a page for the admin to manage mentors, view submissions and observe *Qudwa*'s visitor analytics (Figure 6-11). The admin can create, edit and delete a mentor's profile. Figure 6-12 shows the fields for creating a new mentor profile.

Figure 6-11 *Qudwa* editor page
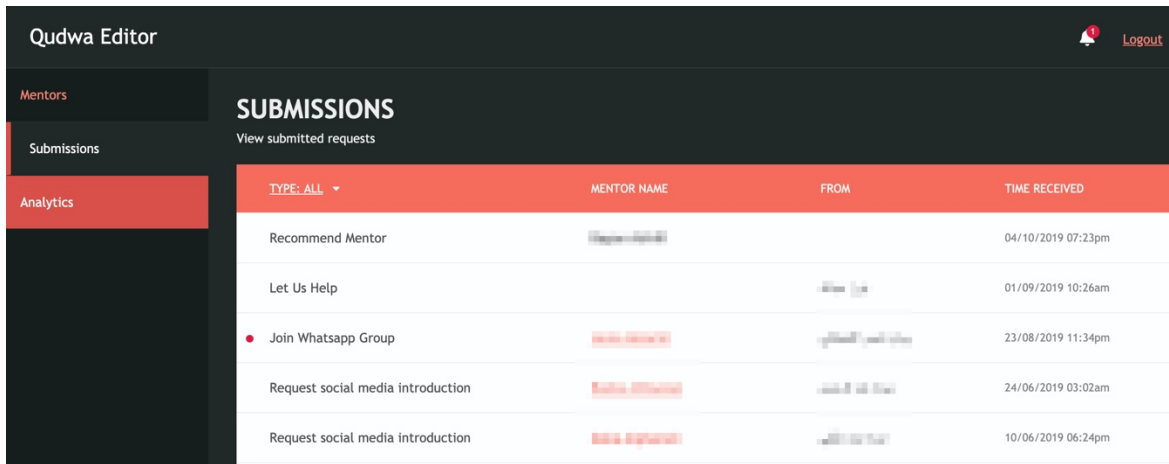
Figure 6-12 Creating a mentor by filling in information in English and Arabic
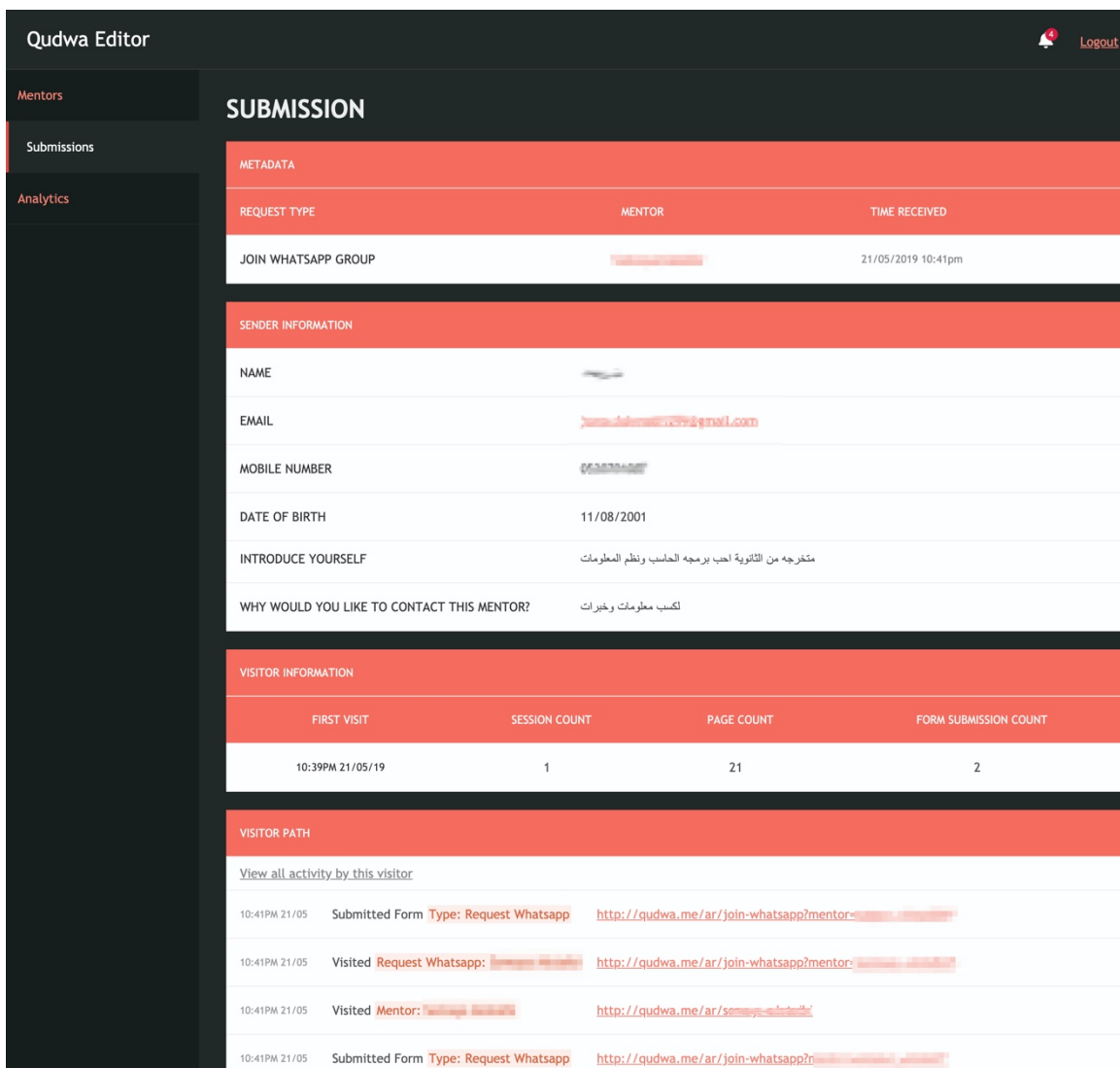
All forms are received on the submissions page for the admin to review and process (RQ4) (Figure 6-13). Information about the mentee and her activity on *Qudwa* is recorded (Figure 6-14).

Figure 6-13 Submissions page

Figure 6-14 A request submitted by one of the mentees

The analytics main page shows an overview of the activity on *Qudwa*, number of visits, number of visitors, top selected tags, top search queries, top visited mentors and top mentors who have been requested to be connected with (Figure 6-15). The analytics also records visitor paths and visitor activity. Visitor activity shows all the activities of users on *Qudwa*. Visitor paths show the individual paths of users and whether they are a returning user or not (Figure 6-16).
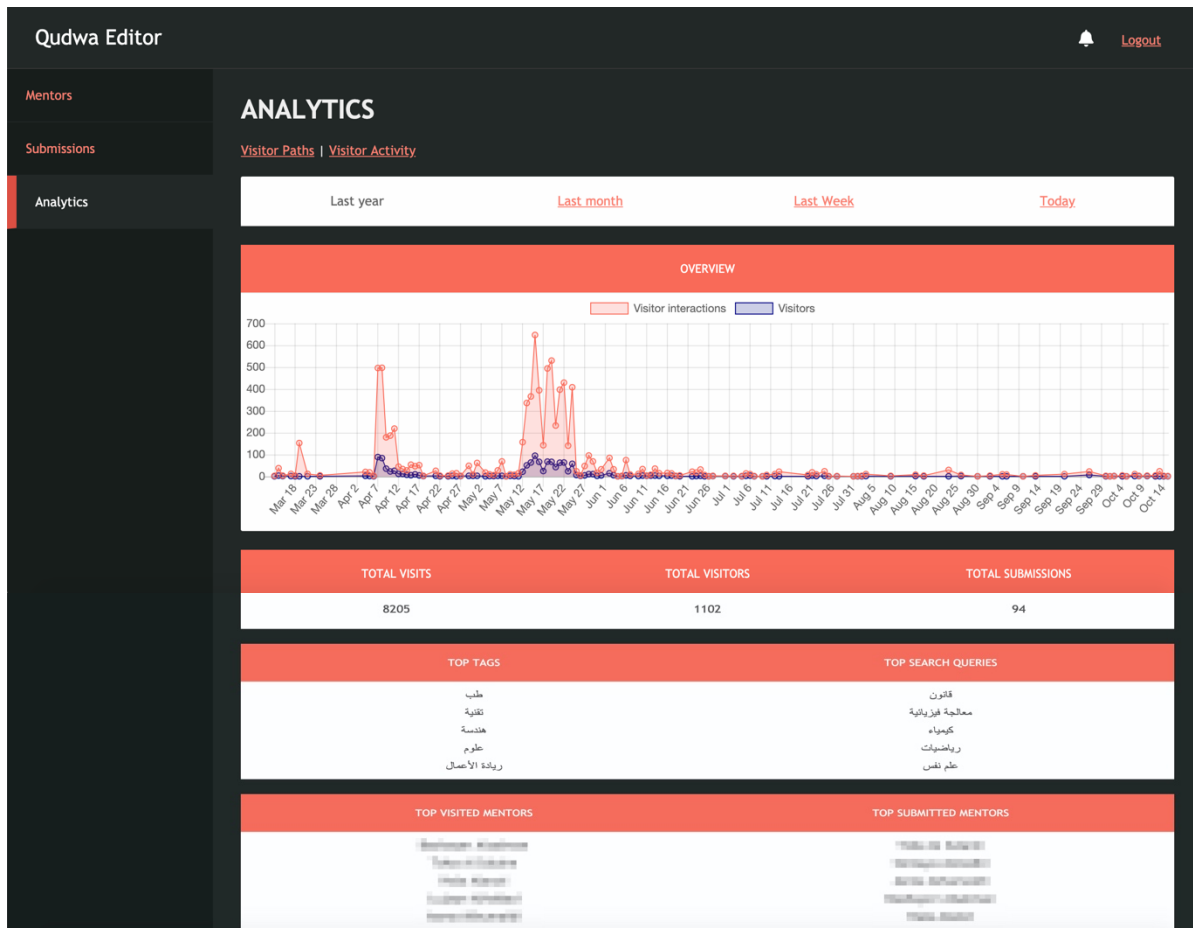
Figure 6-15 Analytics page showing an overview of activity on *Qudwa*
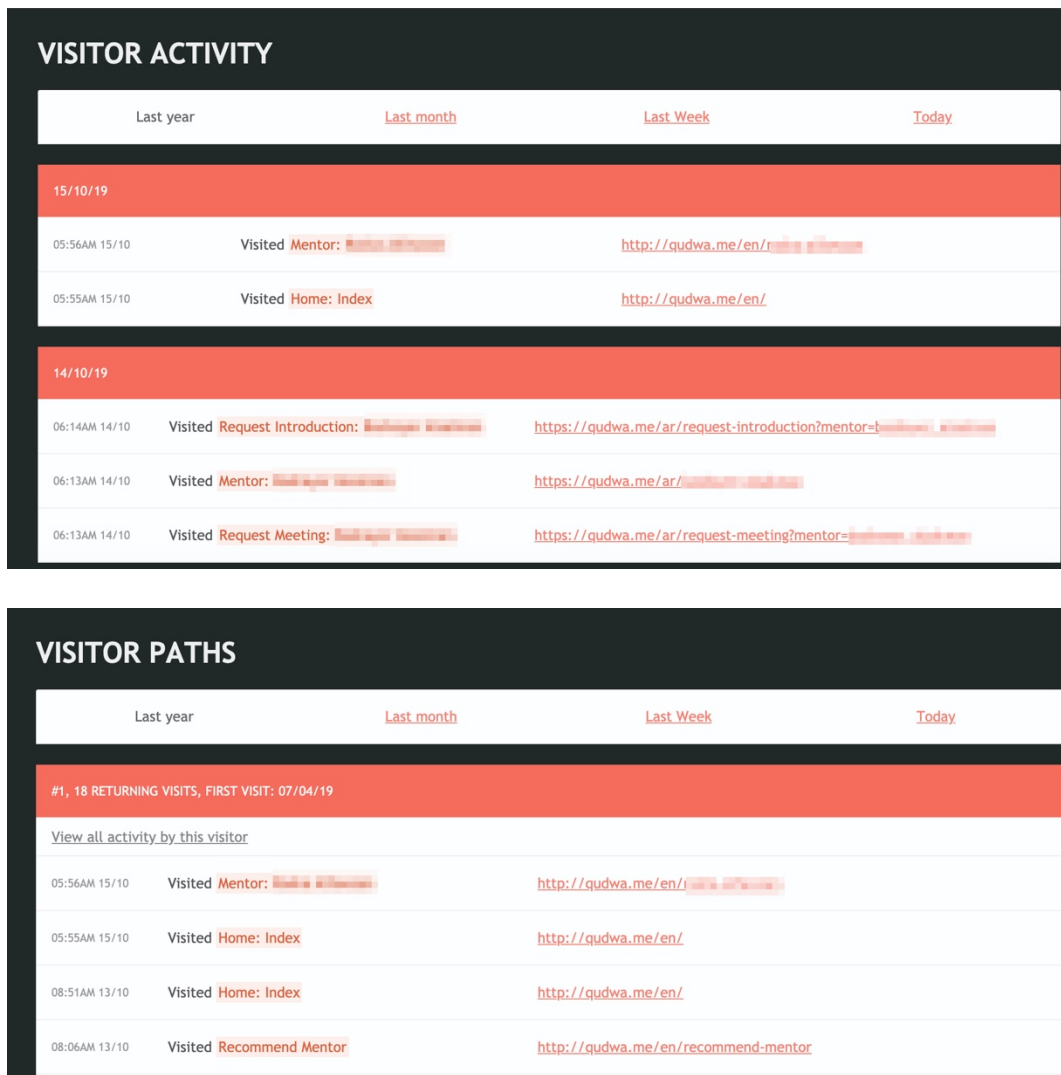
Figure 6-16 Visitor activity shows all activities of users on *Qudwa* (top) and Visitor paths showing individual paths of users and whether they are a returning user or not (bottom).

6.4   Summary

In this chapter I have introduced *Qudwa*, which was designed and implemented based on four design requirements. The design requirements are: 1) flexibility and control; 2) visibility; 3) integration of e-mentoring with daily internet activity; and 4) a trusted connection between mentors and mentees. These requirements were presented and rationalised based on the findings of the previously conducted studies. I have also presented how each design requirement was met in *Qudwa*. The next chapter will present the deployment and evaluation of *Qudwa*.

Chapter 7 Deployment and Evaluation of *Qudwa*

7.1   Introduction

Chapter 6 described the four design requirements: 1) flexibility and control; 2) visibility; 3) integration of e-mentoring with daily internet activity; and 4) a trusted connection between mentors and mentees, in the design of *Qudwa*. This chapter describes the fourth and final study, which shows how *Qudwa* was deployed and evaluated. The chapter begins with the study design including the recruitment and methods used to announce *Qudwa*. Data for this study was collected from submissions, *Qudwa* and social media analytics, a mentees' survey and post-study interviews with mentees and mentors. Each communication method used in *Qudwa* is reported individually. After that, the results of the survey and the thematic analysis of the interviews are presented. Finally, the chapter concludes by presenting the achieved design goals of *Qudwa* supported by the findings of the study and design implications of *Qudwa*.

7.2   Study Design

Qudwa was set to run for two and a half months (April, May and into mid-June 2019) during the end of the academic year and the beginning of the summer vacation in Saudi Arabia. *Qudwa*'s main target groups were female high school graduates and female university graduates. Public universities that are funded by the government and provide free education outnumber private universities in Saudi Arabia. All public universities in Saudi Arabia share a unified admission period, which is set during the summer vacation from mid-June until the beginning of July. Private universities open their admissions in the summer vacation as well.

Therefore, the timing was chosen to maximise the benefits of STEM e-mentoring for the mentees because it is a period that was critical for them in choosing a field to study. The time was also beneficial for university graduates who were looking for jobs, to learn about the opportunities open to them as females. *Qudwa* was not limited to the mentioned target groups but was open to any female who needed mentoring in STEM fields related to work or study. Full ethical review was conducted and approved by the Faculty of Science, Agriculture and Engineering at Newcastle University.

7.2.1   *Recruitment*

Mentors were recruited in the same manner applied in Study 1 (the pilot study). I contacted prospective mentors through my personal contacts and LinkedIn. Mentors who participated in Study 1 were approached as well, but none showed interest in participating further. I looked

for professional women in STEM with a minimum of five years of experience. When approaching a prospective mentor, I described *Qudwa* briefly, and if she showed interest in participating I would send her the research information sheet, the mentor's information form and the consent form. I also shared an online form for joining *Qudwa* as a mentor which was sent through WhatsApp and Twitter. People who signed up to participate in *Qudwa* were filtered based on their field of work and level of experience. Fields were limited to science, technology, engineering and maths with a minimum of three years of experience. Signed-up names who met the criteria were sent the research information sheet, the mentor's information form and the consent form.

For recruiting mentees, participation was open to all young women aged 16–20 years (but not restricted to that age range) in Saudi Arabia, as the aim was to reach mentees from all over the country. Announcements about *Qudwa* were sent through different social media channels. The information sheet for mentees was available online on the *Qudwa* website. Due to the nature of the research, the consent form for the mentees was in an online form.

7.2.2 *Announcements*

Announcements about *Qudwa* were conducted through different channels. To reach out to the target group, a 40-seconds animated video was designed in Arabic explaining the purpose of *Qudwa* and how to use it. Figure 7-1 shows all six scenes that the video displays.

The video was shared on WhatsApp. People were asked to share the video with their contacts. Mentors were also asked to spread the word about *Qudwa* and share the video on their social media accounts. A Twitter account was created to announce *Qudwa* and to reach a larger audience (Figure 7-2). The Twitter promotion was used to advertise *Qudwa* and promote the animation video. The number of visits was high, but the number of submissions did not exceed 10 requests. Due to low participation, an Instagram account was created (three weeks after the beginning of *Qudwa*) to promote *Qudwa* (Figure 7-2). The promotion on both platforms was set to Saudi Arabia and the target audience was females 16–24 years old. Both promotions cost $100 each. The deployment of *Qudwa* was at the time of the summer vacation in Saudi Arabia, so visits to schools were not possible.

Figure 7-1 The first scene (top left) presents the target audience, which is high school and university female students. The second (middle left) and third (bottom left) scenes present the problem faced by the students by asking questions: "Do you need guidance from an expert?" "Do you feel confused between study fields and work fields?" The fourth scene (top right) presents the voluntary nature of *Qudwa*. The fifth scene (middle right) explains how to use *Qudwa* by choosing a mentor and how you want to connect with her. The final scene (bottom right) displays how to reach *Qudwa*.

Figure 7-2 Profiles of *Qudwa* on Instagram (left) and Twitter (right)

7.2.3 *Wizard of Oz*

In this study, I played the role of both 'the admin' and 'the system'. For this study, the term 'admin' refers to the tasks expected to be carried out by a person acting as the administrator and the term 'system' refers to the tasks carried out by me during the study to simulate a possible system. Table 7-1 shows each task and whether it is processed by the admin or the system. When a request is received, the system contacts the submitter through email or WhatsApp to confirm that this is the correct email address and mobile number. In the case of an audio or video meeting, the system contacts the selected mentor, provides her with the information about the mentee and asks her to suggest dates and times that suit her. After that, the system contacts the mentee and asks her to select a convenient time and date based on the mentor's availability. Then the system sends a confirmation email to the mentor and the mentee, stating the time, date and link for the meeting. On the specified date and time, the mentor and the mentee join the meeting. The admin joins the online meetings as well to listen, monitor and record.

Table 7-1 Tasks that are completed by the admin or the system

Task	Processed by	Action
Handling *Let us help* request	admin	The admin contacts the submitter to help her through her problem
Handling Recommend a mentor request	system	An application is sent to the recommended mentor via email
Validating requests	system	An email is sent to the mentee to validate her contact request
Introducing through social media	admin	The admin arranges how the mentee and the mentor will contact each other through the selected social media platform
Creating a WhatsApp group	admin	The admin creates a WhatsApp group for each mentor
Adding to a WhatsApp group	system	The mentee is added to the requested mentor's WhatsApp group
Scheduling online meetings	system	Scheduling
Email confirmation of online meetings	system	An email is sent to the mentee to confirm the date and time of the online meeting
Monitoring interactions between mentors and mentees	admin	The admin monitors all interactions for undesired actions by mentors or mentees

When the system receives the first request to join the WhatsApp group of a specific mentor, the admin creates the mentor's WhatsApp group. Each mentor has her own group, where her mentees will be added upon request. In the case of a *Join a WhatsApp group* request, the system adds the mentee to the group of the selected mentor and introduces her to the mentor and the members of the group, along with her purpose for contacting *Qudwa* (Figure 7-3). In the case of introduction through social media, the admin connects and introduces the mentee to the mentor through the selected platform.
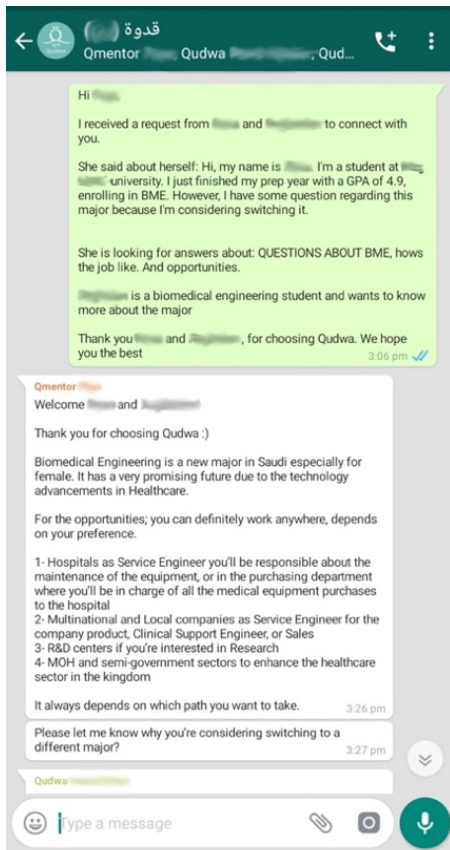
Figure 7-3 Introducing two mentees in a WhatsApp group

7.2.4 *Data collection*

Submissions

All forms submitted by the mentees were collected for analysis.

Observations

All sessions between mentors and mentees were recorded, including WhatsApp transcripts, audio recordings of online meetings and transcripts of interactions between mentors and mentees on social media platforms. The content helped in understanding the relationships between mentors and mentees. Some of the interview questions were derived from the interactions and behaviours of the participants.

Analytics

Two types of analytics were collected, one from the social media accounts (Twitter and Instagram) used for promoting *Qudwa* and the other from *Qudwa* itself. The analytics and numbers collected from the Twitter and Instagram accounts showed user engagement with the promotions. *Qudwa* recorded the number of visits, visitors, paths and activity of users. The analytics helped in knowing whether a user was a returning one or a new visitor and also in

viewing the path of that visitor, which pages she visited and which mentors she viewed. Due to privacy, a single visitor could not be identified unless she submitted any form, whereby she could be identified. The analytics were used in the interviews to understand the patterns of mentees.

Survey

An online survey was sent to the mentees by the end of the study. It discussed three aspects: the nature of the relationship, communication channels and the impact of *Qudwa* on them. The nature of the relationship asked about the mentee's experience with mentoring, Qudwa and the mentor. It also asked how the mentee perceived her mentor and their relationship. The communication channels section asked about the available channels used in *Qudwa* and the proposed channels for communicating and promoting. It also asked for the mentee's feedback and reason for choosing these channels. The impact of *Qudwa* section asked about how comfortable the mentee was in asking questions and how their participation helped them. It asked about the role of the intermediate person as well. The survey was in Arabic.

Interviews

Interviews were conducted with mentors and mentees by phone and through WhatsApp to discuss their experiences with *Qudwa*. All interviews were conducted in Arabic. Phone interviews were conducted with four mentors who agreed to be interviewed. Each interview lasted for approximately 40–60 minutes. Three of the mentors had been in contact with mentees through WhatsApp groups and audio online meetings, while one mentor had only contacted her mentees through a WhatsApp group. Requests for interviews were sent to 20 mentees through WhatsApp. The mentees who had shown significant behaviours were selected, for example, a mentee who changed her requests several times, a passive mentee and a mentee who missed her meeting. As a result, a total of ten interviews were conducted. Four mentees agreed to have a phone interview, while another five mentees desired to answer the questions through WhatsApp. One participant (identified as Submitter1), who submitted a *Let us help* form but did not submit a contact request, was sent an interview request and she agreed to be interviewed by phone. All interviews lasted 15–20 minutes. All interviews were post-study except for one mentee, who was interviewed during the deployment of the study to understand the problems or reservations she had that might have led to the low engagement with *Qudwa* at the beginning of the study.

The interview questions were of three types: general, based on my observations and interviewee-specific. The interviews were open semi-structured and led by the interaction and

answers of the interviewee. The general questions were asked to all the interviewed mentors, covering their previous mentoring experience, their experience with *Qudwa* and their opinion of the channels. Some questions were a result of my observations from the audio online meetings, WhatsApp chats and mentees' interviews. These questions addressed the repetition of mentees' questions, the complete inactivity (passiveness) of some mentees, the feedback or appreciation from mentees and why the mentees did not leave the WhatsApp group. Other questions were interviewee-specific based on the activity and interaction of the mentor or mentee on *Qudwa*.

7.3   Findings and Analysis

In this section, the findings of the study are presented, starting with the results for the recruited mentors, followed by a report on the overall submissions received. Then the collected data about mentees' demographics and their reasons for joining *Qudwa* is documented and analysed. The following sections talk about the findings for each communication method: WhatsApp groups, online meetings and introduction through social media. Finally, the results of the online survey are reported, followed by analysis of the interviews conducted with mentors and mentees.

For identification, the mentors are identified by '*Qudwa*' then a number from 1 to 15. Numbers are based on the alphabetical order of the mentors' first names, for example Qudwa1. Mentees are numbered based on the order of their requests. The first to send a request is identified as Mentee1 and so on.

7.3.1   *Mentors*

A total of 15 mentors completed the forms they were sent and were recruited. Seven of the mentors shared their personal photos. Mentors were asked to tag themselves with science, technology, engineering or math, and they could tag more than one and use any other tags that they thought fit their specialty. Some of the mentors had overlapping tags, for example, engineering and technology or technology and science. Five mentors tagged themselves with science, 11 tagged themselves with technology and four tagged themselves with engineering (Figure 7-4). There were no mentors with maths backgrounds. Two tagged themselves with science and technology, and three tagged themselves with technology and engineering (Figure 7-5).
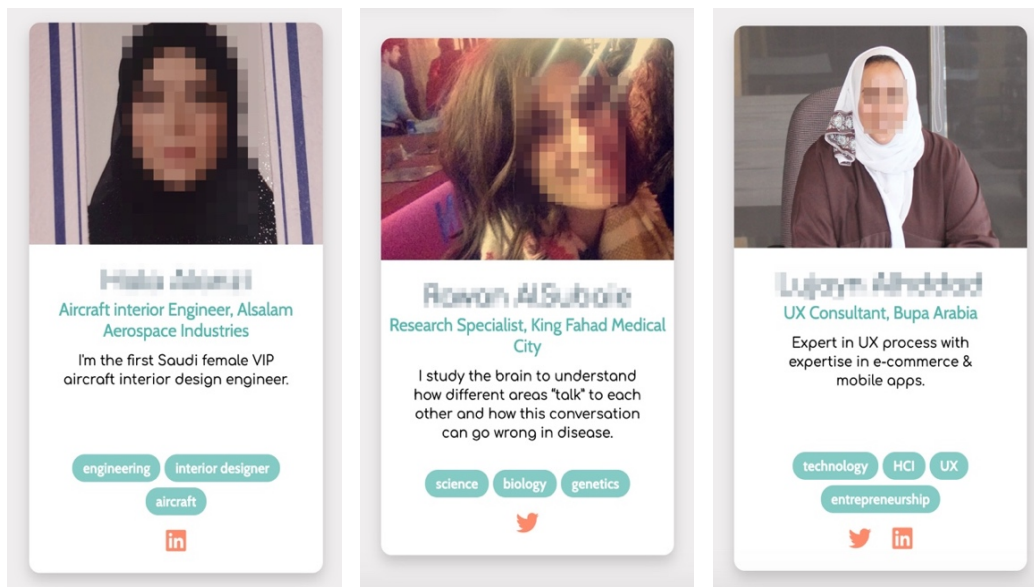
Figure 7-4 Examples of mentors with engineering, science or technology tags
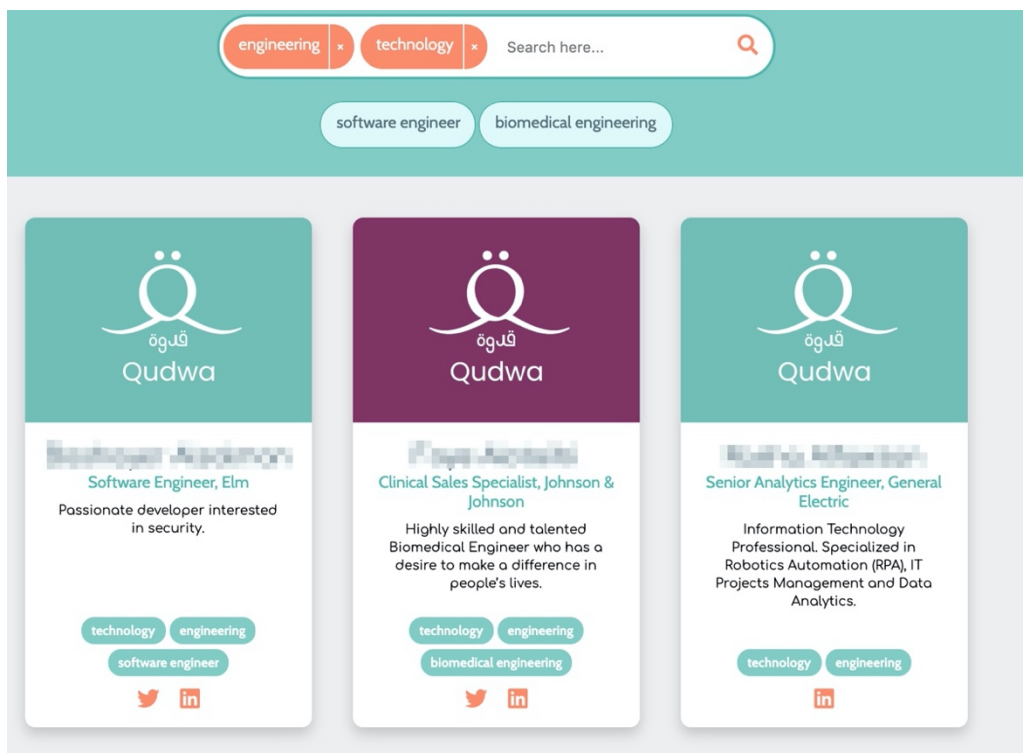
Figure 7-5 Profiles of the three mentors who tagged themselves with technology and engineering

Six mentors shared only their Twitter accounts, two shared only their LinkedIn accounts and five shared their accounts on both platforms. One mentor shared her Twitter account and her personal webpage, and another shared her Twitter and Facebook accounts.

The tags that were created by the mentors were: developer, software engineer, genome, bioinformatics, biomedical engineering, interior designer, aircraft, biotechnology, HCI, UX, biology, genetics, health, web and medicine.

7.3.2 *Submissions*

A total of 82 submissions were received (Table 7-2). Some submissions were sent from the same mentees and others changed their request after the system got in contact with them. Some requests were not fulfilled because the mentee did not reply to the system. Table 7-3 shows the number of submissions for each communication method received for each mentor. Qudwa9, Qudwa10 and Qudwa11 did not receive any submissions.

Table 7-2 Total number of submissions and number of each type of request

Type of request	Number of submissions
Join a WhatsApp group	23
Online meeting	8
Introduction through social media	11
Let us help	23
Recommend a mentor	15
Total submissions	82

Table 7-3 Number of submissions received for each mentor

	Join WhatsApp group	Online meeting	Introduction through social media
Qudwa1	1	1	0
Qudwa2	3	2	0
Qudwa3	1	0	1
Qudwa4	1	0	0
Qudwa5	4	0	0
Qudwa6	3	0	1
Qudwa7	1	0	0
Qudwa8	1	1	1
Qudwa9	0	0	0
Qudwa10	0	0	0
Qudwa11	0	0	0
Qudwa12	0	1	1
Qudwa13	1	0	1
Qudwa14	2	2	3
Qudwa15	4	1	3

Table 7-4 shows the multiple submissions sent by individual mentees. Six mentees requested to connect with more than one mentor, using the same method or different methods. Two mentees asked to join the WhatsApp groups of two different mentors. One mentee sent two requests to have audio online meetings with two mentors. Another mentee requested to join a WhatsApp group with one mentor and an audio online meeting with another mentor, and one mentee had three requests, two audio online meetings with two mentors and a request to join a WhatsApp group with a third mentor. All multiple submissions were sent on the same day by the mentees except for one mentee, who submitted the second request 20 days after her first submission.

Table 7-4 Number and type of submissions sent by the same mentee

	Join a WhatsApp group	Online meeting	Introduction through social media
Mentee3	2		
Mentee6	1		1
Mentee16		2	
Mentee17	1	1	
Mentee26	2		
Mentee28	1	2	

Some mentees changed their requests after the system got in contact with them. Mentee16 originally requested two audio online meetings with two different mentors, but when the system contacted her, she changed her request to joining the WhatsApp groups of the two mentors. She explained: "WhatsApp is easier for me to explain what I want with ease"*. Mentee17 had requested an audio online meeting, but after the system contacted her, she changed her mind and asked to join the mentor's WhatsApp group. After joining the WhatsApp group, she again asked for an audio online meeting with the mentor.

All mentees requested to be connected with different mentors within the same field except for two mentees. One was a first-year undergraduate studying biomedical engineering and she was thinking of changing her major to computer science. Therefore, she asked to be connected with two mentors, one in the field of biomedical engineering and the other in the field of computer science. The other mentee had an interest in the medical field and she asked to be connected with one mentor in the field of medicine and one in the field of biomedical engineering. This behaviour can be explained due to the fact that mentees are seeking

information and may contact several mentors in the same field or different fields. Mentee17 had a specific reason for this but the others were collecting knowledge and information from all available resources (mentors on *Qudwa*).

Let us help

The total of *Let us help* submissions was 23 from individual submitters. Seventeen submissions were requesting fields not supported by *Qudwa* such as finance, arts, translation, fashion design, law and business. Only six submitters were requesting help in a STEM field. Two mentees asked to be put in contact with a mentor via WhatsApp after the admin contacted them. One mentee was found to have submitted another request to join a WhatsApp group. The remaining three were contacted by the admin; two did not reply and one said that she would submit a request but she did not.

Three mentees submitted a *Let us help* form even though the fields they were requesting were available on *Qudwa*. One mentee requested help and before the admin contacted her, it was found that she had submitted a form requesting an audio online meeting with a mentor. She explained in her interview that she had submitted the help form even before she explored *Qudwa*. The admin contacted the others to help them with their needs.

One participant, identified as Submitter1, submitted a help form but did not proceed and submit a contact form after the admin contacted her. Through the interview, she explained that she had not submitted a form to contact a mentor because she wanted to be ready and have enough background about the field before she talked to a mentor.

Recommend a mentor

The system contacted all 15 recommended mentors by email and sent them an information sheet, but no response was received. It is not possible to know whether the recommendations came from the person herself who wanted to be a mentor on *Qudwa* or someone else had suggested that she could be a mentor.

7.3.3 *Mentees*

Qudwa had a total number of 1107 original visitors and 8288 repeat visits. The total number of participating mentees was 35. In the submission forms there were two textboxes, one asking the submitter to introduce herself and the other to specify the reason she was requesting to contact the mentor. This helped in learning about the mentees.

At the time of the study, most of the mentees (18 mentees) were at the age of 18 years, had graduated from school and were applying for university. *Qudwa* was mainly targeting

females who were graduating from high school (or younger) and undergraduates to guide them through university applications and career paths, but surprisingly the findings show the participation of older age groups (Table 7-5). Of the 35 mentees, 28 mentees (80%) were 19 years old or younger, which is the age of high school graduates, and three mentees were undergraduate students.

Older mentees used *Qudwa* to learn about other fields that they did not have a background in or were not familiar with. The eldest mentee was Mentee4 (34 years old); she wanted to learn about a field that she was not familiar with. Her background was in the Arabic language and she used *Qudwa* to increase her knowledge about a technical field. She mentioned in the submission form that she had looked at many websites, but had not found information that could help her:

> I am a graduate of the Arabic language department and I hope to become knowledgeable about the technical field … I searched on several websites, but I could not find useful information to help me.* – Mentee4

The same with Mentee2 (23 years old), who was interested in business and technology while her major was languages and translation. She joined *Qudwa* because she was passionate about learning new things and to figure out which path to take regarding her career.

On the other hand, Mentee3 (28 years old) was a postgraduate student seeking knowledge from the mentor's experience. Mentee14 (23 years old) was general in her request and purpose for joining Qudwa.

Table 7-5 Age group of mentees

Born in	Age	Number of mentees
1985	34	1
1991	28	1
1995	24	1
1996	23	1
1997	22	1
1998	21	1
1999	20	1
2000	19	5
2001	18	18
2002	17	3
2003	16	2

To understand the mentees better and have some initial background about them, they were asked to write a brief introduction about themselves and their purpose for contacting the mentors. The next sections will present the findings from their submissions.

How the mentees introduced themselves

In the textbox *Introduce yourself* most of the mentees (68.5%) described themselves briefly, mainly mentioning their name, education level and age. Some added a few words to describe themselves:

> I'm ****, I'm 18 years old and I live in Jeddah.* – Mentee8
>
> I study biomedical engineering. – Mentee18

The remaining mentees (31.5%) described themselves in more detail than the examples above. They talked about themselves, what they wished for and their hobbies and interests in general:

> I am a Computer Information Systems student at **** University, I consider myself a perfectionist, I have very high expectations of myself. I'm confident in my ability to work hard and deliver quality results, I always try to develop myself by participating in many volunteering activities and taking courses in my field of study and beyond. – Mentee5
>
> Hi, my name is ****. I'm a student at **** university. I just finished my prep year with a GPA of 4.9, enrolling in BME. However, I have some questions regarding this major because I'm considering switching it. – Mentee17

Mentees' purpose for contacting the mentor

In the textbox *Why would you like to contact this mentor?* the answers were divided into two groups. The first group wanted to learn: learn about the experience, learn about the field, learn about job opportunities and learn about the struggles faced by the mentors. The other group was looking for guidance and advice on applying to universities, choosing a major or guidance on a specific field (Table 7-6).

Five mentees wanted to learn about the mentor's experience; for example:

> To benefit from the experience and knowledge of Ms *****. – Mentee3
>
> I want to benefit from the experience of people who have majored in this field.* – Mentee22

Table 7-6 Why the mentees were requesting to contact the mentors

Mentees' purpose for contacting the mentor		
		Number of mentees
Learn about	experience	5
	field	13
	job opportunities	4
	the struggles and difficulties	3
Guidance and advice on		
	choosing a major	9
	applying to universities	2
	career future	1
	a specific field	6

Others wanted to learn about the field and job opportunities. Mentee2, who was a fresh graduate, wrote:

> Because I want to learn more about business analysis and technology and which path I can take regarding my career.

Mentee17, who was an undergraduate, wrote:

> Questions about BME, hows the job like. And opportunities. I would like to contact this mentor because I find her cv very interesting and inspiring.

Some mentees wanted to learn about the struggles and difficulties faced by the mentor as a female in the work environment:

> I would like to gain experience – to ask more about the field of this role model – maybe in the future I will become like her – I would like to ask about the universities that provide her field – to deepen the understanding of this field – and to know the difficulties encountered by this role model.* – Mentee12

> To increase my knowledge about the health track in the university and to identify the difficulties in this field to overcome them in the future, God willing.* – Mentee7

Other mentees were seeking guidance and advice from mentors. Some were looking for advice about the field from someone specialised in that field:

> I have just taken my HCI course in college and it opened my eyes literally on the design of every site and app. Definitely, an area that I'm interested in and want to give more to, and I would love the opportunity to learn more about it especially in the UX field. I need some advice about how to be present in this field, what would be my next step? I'm really interested in working in projects related to this field where do you think I should go? – Mentee5

I need guidance and advice from someone specialised in the field because they are the ones who we should ask.* – Mentee6

The majority were seeking advice in choosing their majors. Some mentees showed despair and uncertainty in their submissions. Two mentees were seeking guidance and advice on applying to university:

I'm confused about the major I should pick at college and I have some interests in software engineering, but I'm looking forward to knowing more about it. – Mentee1

I need advice and instructions on how to register at the university.* – Mentee19

7.3.4   *Introduction through social media*

Seven of the *Introduction through social media* requests were asking to contact the mentor through a platform that was not provided by the mentor herself. Five requested to be introduced through Instagram and two through Snapchat. Four requested introductions through Twitter. All submitters who had requested to be in contact through Instagram or Snapchat were contacted by the admin, who clarified that these platforms were not provided by the mentors. The admin also suggested the use of other available methods on *Qudwa*.

There was a problem with creating a group on Twitter for a mentor, a mentee and the admin to join because the mentee had a private account and Twitter requests that members of a group should be following each other. Therefore, after the first attempt had failed, any further requests to be introduced through Twitter were responded to by the admin with the suggestion of using other methods. Nine of the submitters chose to join the WhatsApp group of their selected mentor, one did not reply to the admin and one request was overlooked by the admin.

7.3.5   *Join WhatsApp group*

The number of submissions to join a WhatsApp group was 23, but the total number of mentees in the groups was 34. The difference in numbers was because of the changes in the requests of the mentees. Two mentees had submitted two requests to join two different groups and nine mentees had originally requested an introduction through social networks but, as explained earlier, they joined WhatsApp groups. Two mentees asked to join their mentor's WhatsApp group after they had an online meeting with them. Two asked to join the WhatsApp group after the admin had contacted them upon their *Let us help* submissions. One mentee requested an online meeting, then changed her mind and wanted to join the mentor's WhatsApp group.

Some groups acted as a one-to-one relationship between a mentor and a mentee. Qudwa1, Qudwa3, Qudwa4, Qudwa7, Qudwa7, Qudwa8 and Qudwa12 had only one mentee in their groups. The highest number of mentees in one group was 11 in the group of Qudwa15 (Table 7-7).

Table 7-7 Number of mentees in each WhatsApp group

Mentor	Number of mentees in group
Qudwa15	11
Qudwa2	4
Qudwa5	4
Qudwa14	4
Qudwa6	3
Qudwa13	2
Qudwa1	1
Qudwa3	1
Qudwa4	1
Qudwa7	1
Qudwa8	1
Qudwa12	1

Among my observations of the WhatsApp groups, some behaviours were noted: 1) passive mentees; 2) lack of response from mentees; 3) leaving/staying in a group; and 4) lack of appreciation from mentees. Some mentees did not participate at all after they were added to a group. The admin introduced them, their questions and the reason they wanted to contact the mentor, and the mentor replied to their questions, but there was no further response from the mentee. This behaviour occurred several times in different groups. Mentee29, who asked for an interview but replied through WhatsApp, was passive in the group and then left the group. She explained that what happened was not what she had expected and that she had expected it to be a training session or a course. On the other hand, Mentee11, who was also passive, expressed that she felt weird asking the mentor when the group was sometimes inactive:

> I don't know, maybe because the group was silent and there was no activity,
> I felt weird asking suddenly.* – Mentee11

Other mentees were interactive for some time and then suddenly inactive. This was obvious when there was a conversation going on between a mentor and a mentee in the group

and the mentor was responding to the mentee, but the mentee did not respond or show any sign of receiving of the information or response the mentor had shared.

In conducting the interviews with the mentees and conducting the survey, a large amount of appreciation was shown by the mentees. This made obvious the lack of appreciation or thankfulness in the WhatsApp groups.

7.3.6   *Online meetings*

There were eight requests for audio *Online meetings* but the meetings actually conducted numbered six because one mentee had requested two meetings with two different mentors but, after the system contacted her, changed her mind to join one of the mentors' WhatsApp group and cancelled her request to contact the other mentor.

All the six online meetings were conducted on time except for two cases where the two mentees missed their scheduled meetings with their mentors. In the first case, the admin tried to contact Mentee1 via email (she did not provide her mobile number) after the meeting had started, but she did not reply. The mentor kindly agreed to wait for 20 minutes, but the mentee did not show up. The next day, the mentee apologised and explained that she had had an urgent matter and could not join the meeting, and she requested a second chance. The mentor agreed and the meeting was conducted on another date and time.

In the second case, Mentee28 had booked two meetings on different dates with two different mentors, and missed the first meeting even though the system reminded her 15 minutes beforehand via WhatsApp and she confirmed. The admin tried several times to reach her again through WhatsApp. The mentor agreed to wait for 20 minutes, but the mentee did not show up. Forty minutes later, she explained that she had thought it was a phone call. The meeting was rescheduled and conducted the next day. On her second meeting with the other mentor, she was 30 minutes late. Her excuse was that she was not at home. Mentee1 was apologetic and tried to reach and explain to the admin, while Mentee28 did not try to reach out to find why the meeting did not happen or whether the mentor was late.

7.3.7   *Survey*

An online survey was sent to all mentees who participated in *Qudwa.* The survey link was sent through WhatsApp. Out of the 35 mentees, 21 completed the survey. The survey discussed three aspects: the nature of the relationship, the communication channels and the impact of *Qudwa* on the mentees. This section presents some of the survey questions.

Nature of the relationship

Have you ever talked to a professional to help you find answers regarding your studies or career?

Seven out of 21 mentees indicated that they had contacted a professional to seek help before they participated in *Qudwa*. One mentee elaborated that she had done a test with a professional from her university to help her choose a suitable major. Another mentee mentioned that she had asked through people she knew in the community. Seven out of the 14 mentees who indicated that they had never contacted a professional before explained their answers:

> I have talked with people who had experience, but not professionals.*

> I tried asking professionals on social media, but I did not get any responses.*

How would you rate your overall experience with Qudwa?

The Likert scale ranged from 1 (very bad) to 7 (very good). The results show that 11 out of the 21 mentees described their experience with *Qudwa* as very good, four as good, five as somewhat good and one was neutral. There were no ratings below neutral.

How do you rate your experience with the mentor in terms of her ability to help you?

The Likert scale was from 1 (very bad) to 7 (very good). On rating the mentors that they were in contact with, 15 out of the 21 mentees rated their mentors as very good, two mentees rated their mentors as good and three mentees as somewhat good. There were no ratings below neutral (one mentee).

I felt the need for more guidance and help than Qudwa provided

The Likert scale was from 1 (strongly disagree) to 7 (strongly agree). The results show that five of the mentees strongly disagreed and three of the mentees strongly agreed that they needed more guidance and help. Five of the mentees were neutral.

The available information about each mentor was enough for you to decide which mentor to choose

The Likert scale was from 1 (strongly disagree) to 7 (strongly agree) and the results show that

the majority of the mentees agreed (six mentees strongly agreed, four mentees agreed and another four mentees somewhat agreed) and one mentee strongly disagreed, while two were neutral.

How do you feel about the short-term relationship with your mentor?

The Likert scale was from 1 (strongly dissatisfied) to 7 (strongly satisfied). The results show that the majority of mentees were satisfied with the short-term relationship (eight out of the 21 mentees were strongly satisfied, six were satisfied and three were somewhat satisfied), 13 mentees were neutral and one mentee was somewhat dissatisfied.

Could your experience with Qudwa be replaced by a Q&A website, and why?

The Likert scale was from 1 (strongly agree) to 7 (strongly disagree). The results show that eight of the 21 mentees strongly disagreed, five somewhat disagreed and four disagreed. The results also show that one mentee strongly agreed and another mentee agreed, while two mentees were natural.

One mentee who rated the replacement of *Qudwa* with a Q/A website with *somewhat agree* justified her answer:

> I might find a question that formulates what I'm thinking of. Instead of being distracted by formulating the question, I might find someone who had the same questions and asked them better than me.*

The other mentees who thought that *Qudwa* could not be replaced:

> Nice idea but an old one, because it will almost become the same as forums that 'ask questions and get people to answer' but on social networking sites such as WhatsApp and Twitter I see that it is better because it is the most widespread means of communication in this era and with more interaction.*

Communication channels

How did you know about Qudwa?

Most of the mentees knew about *Qudwa* from Twitter and Instagram (nine and eight mentees). The results also show that three knew about *Qudwa* from WhatsApp. One mentee mentioned that she knew about *Qudwa* from a friend.

What other channels would help promote and reach more girls?

This question had multiple options: Twitter, Instagram, WhatsApp and other [specify]. The

respondents were asked to select all that applied. Twitter was chosen the most (16 responses), followed by WhatsApp (11 responses) and then Instagram (six responses). Two social media platforms were suggested by the mentees: Telegram and Snapchat.

Why did you choose your communication channel?

The question had multiple options and the respondents were asked to select all that applied. The options were: 1) ease of use; 2) I use it a lot; 3) I feel confident using it; 4) privacy; 5) ease of expressing myself; 6) other [specify]. *Ease of use* had the majority with16 responses, followed by *ease of expressing myself* (10 responses). The results show that *I feel confident using it* got seven responses, *I use it a lot* got six responses and *privacy* got five responses. Two mentees who communicated through WhatsApp added other reasons, one that she wanted to try it out and the other that the method attracted her.

Did you face problems with the chosen communication channel?

All mentees responded with no except for one, who wrote that she faced problems with scheduling.

What channels do you prefer to use other than the one used in Qudwa?

This question was a short-answer textbox. Five mentees answered that there were no other channels that they preferred. Four mentees left the question unanswered. Two mentees mentioned WhatsApp, one of them saying: "WhatsApp is the fastest and most private method"*. One mentee suggested the use of the application Zoom because in her opinion most people used it for calls. One mentee preferred the existence of a standalone application for *Qudwa* where she did not have to share her information such as phone numbers. Another mentee recommended the use of groups to benefit from others' questions and discussions. One mentee wanted to use an application that allowed calls without specifying which application. Others suggested: Twitter, Telegram, Snapchat and Instagram.

Did you have any reservations regarding your participation in Qudwa?

The question had multiple options and the respondents were asked to select all that applied. The options were: 1) no reservations; 2) privacy; 3) communicating with strangers; 4) the nature of the communication channels; 5) other [specify]. More than half of the mentees (16 out of 21 mentees) had no reservations.

Did you visit the mentors' social media accounts provided on Qudwa?

More than half (12 mentees) answered "No". There was a follow-up question: "If yes, did you find providing the social media accounts of the mentors beneficial to you?". All who answered "Yes" answered the follow-up question with "Yes".

The impact of Qudwa on the mentees

How comfortable were you asking the mentor questions?

The Likert scale was from 1 (strongly uncomfortable) to 7 (strongly comfortable). The highest percentage of mentees felt comfortable asking questions (17 out of 21 mentees) and only two mentees felt somewhat uncomfortable.

How do you rate the effect of displaying all the mentors from different fields to you to raise your awareness about study and career options?

The Likert scale was from 1 (strongly ineffective) to 7 (strongly effective). The results show that the majority of the mentees felt that displaying the mentors' profiles on *Qudwa* was effective in terms of raising their awareness of opportunities for them.

How do you feel after your participation in Qudwa?

The Likert scale was from 1 (strongly confused) to 7 (strongly determined). The results show that 16 out of 21 mentees felt more determined than before their participation in *Qudwa* (seven were strongly determined, six determined and three somewhat determined) and only one mentee felt somewhat confused.

How helpful was the presence of an intermediate person (Aseel) for guiding and communicating in comparison to an automated system?

The Likert scale was from 1 (strongly useless) to 7 (strongly helpful). The results show that most of the mentees found the presence of an intermediate person helpful, while two mentees found it useless.

If you had the chance to make changes to Qudwa, what would you change or add?

The results showed that seven of the mentees thought that *Qudwa* did not need any changes. Some of them elaborated:

No changes needed; the system is good as it is.*

Qudwa does not need to change, I hope it develops and adds more fields.*

Nothing, I wish it continues. Many thanks.*

Some mentees added their suggestions for change. One mentee wrote: "speed of response"*, another added: "an app for Qudwa"*. One mentee suggested adding activities and introductory information about the mentors. Two mentees proposed that *Qudwa* add mentors from more fields. One mentee suggested promoting *Qudwa* so that more girls benefited from it. One mentee said: "As I mentioned earlier, in groups with other people – the mentor asks questions that help the user determine their choice – the questions are not unliteral"*.

7.3.8 *Interviews*

Thematic analysis was applied to all interviews with mentors and mentees. The interviews were analysed using the inductive approach of Braun and Clarke (2006). Several themes were identified: the need for *Qudwa*, impact and influence, differences between mentors and mentees, cultural factors and *Qudwa* and mentors' daily activity.

The need for Qudwa

In addition to the reasons that *Qudwa* was initiated in the first place, which were to guide and help young women due to the lack of mentoring and resources in Saudi Arabia, other needs emerged too. The analysis showed that *Qudwa* was a means for the mentors to help themselves on a personal level. Despite the existence of people around them and professionals on social media platforms, the participants felt certainty and trust in receiving a response from *Qudwa*. Some interviewed mentors and mentees expressed their wish for *Qudwa* to continue and grow.

Lack of mentoring and resources

The lack of mentoring and the gap between schools and workplaces discussed in previous studies re-appeared in this study. Mentors explained their previous experiences when they were young and how they needed support and guidance:

> We've been through that 'looking for help' phase and now that we've been through it, we want to help others. We didn't have this kind of support when we needed it, so why don't we help the younger generation?* – Qudwa8

Qudwa8 added later on that she had shared the concept of *Qudwa* with people she was working with in the UAE. They were working on a project to guide and mentor fresh

graduates through their career paths. Qudwa5 and Qudwa14 talked about their past experiences of choosing fields (biomedical engineering and electrical engineering) that were not widely known as options for females in Saudi Arabia:

> The options are completely unclear. For example, electrical engineering was provided only at *** university several years ago. I loved physics and I thought that electronic engineering was a good option for me. But what would be my job? I didn't have any vision of what a female could be with an electronic engineering major … If there was *Qudwa* at that time, I would definitely have used it. And especially if she's a female! I would ask her what will I study? What do you do? Where can I get a job?* – Qudwa14

Qudwa2 stressed the gap in the concept of computing between what is learned in schools and universities and what a person with a computing major actually does. Qudwa14 emphasised the lack of Arabic resources and content available online that would help students in understanding and finding answers to their needs regarding future planning. She explained that she was surprised that girls would still ask questions about the differences between computing fields even though computing had been taught in Saudi Arabia for many years. She thought that this kind of information should be well known by now.

From the mentees' side, the need for *Qudwa* was present too. They had questions that they could not find answers to, they needed to be inspired and they needed guidance from someone professional. Mentee23 expressed that *Qudwa* was needed among girls her age. She described her experience with *Qudwa*:

> It solved the problem of girls my age, they need someone to guide them and advise them. They have lots of questions and they wish someone will give them answers … There were questions on my mind without answers and I found my answers … Lots of people will benefit and find answers to their questions. Some people are devastated, they have nothing on their minds, they don't have a goal. If they read about other people's experiences, they will be encouraged.*

Mentee13 confirmed the thoughts of Qudwa2 and Qudwa14 on the confusion in understanding the differences between fields. She reported:

> I needed more information about the computing fields and the differences between them, because there were many fields.*

Among all the interviewed mentees, Mentee5 was focused and specific about what she needed. She was in the final year of her undergraduate study. She sought guidance on how to proceed and plan her career path.

The certainty of receiving a sufficient response on Qudwa

In talking about their reasons for joining *Qudwa*, mentees reported that they had previously sought help using other methods, which included their relatives and professionals on social media. They had reached out for help through their relatives and people around them, but the information they needed was not provided. They mostly did not receive a response from professionals on social media, and if they did the answers were insufficient. They believed and were certain that mentors on *Qudwa* would respond adequately. The reason behind their certainty was because these mentors had volunteered themselves with the intention of helping and guiding through *Qudwa*. The comments below present the mentees' thoughts:

> I did try to contact a professional before, but it took a long time for her to respond to me, or she didn't provide a way to communicate. She just provided answers [on her website] to what she thought are the most expected questions. Most of them do not provide the opportunity for us to contact her in person.*
> – Submitter1

> Honestly, with social media like LinkedIn and Twitter, yes there are many, but I don't have the confidence that she will reply to me like being on this website [*Qudwa*]. I might and it happened, honestly, that I asked people through email, but they didn't reply. But on *Qudwa* I was sure that someone would reply to me.* – Mentee5

The certainty of receiving a response was also noted in Qudwa14's response when she was asked if she would use *Qudwa* for a professional-to-professional connection:

> Yes, I would contact her on *Qudwa* and not on her personal account on LinkedIn, for example. Because I know she is willing to help. The concept of *Qudwa* helps you to ask without feeling that you are intruding or annoying them. People honestly don't reply on LinkedIn.*

She also discussed how the girls around her did not get responses from people and if they got responses, they were brief. I asked if those girls got answers and she responded:

> No, unfortunately. People don't respond to them. They rarely get answered and if they get an answer, it would be brief and it doesn't satisfy them.*

Personal benefits for mentors

The mentors felt that *Qudwa* was beneficial for them on a personal level. It satisfied their needs to give and help, feel better about themselves and create a positive change in their lives. Qudwa8 expressed that she felt she had responsibilities towards her field, towards young females and towards her society. She reported:

> First of all, I love to help in general, especially helping the new generation. Second thing, it encourages girls to be in our fields, STEM fields. It's our responsibility to encourage girls to go into these fields. And I have another responsibility, because my field is new and is not well known here in Saudi while it is wanted on the job market. It's an opportunity to make girls know about it, think about it and guide them to it ... so a responsibility towards society, my field and the girls.*

Two mentors had thought of their participation in *Qudwa* as a way to make positive changes in their lives. Qudwa2 needed to enrich her life with something that she enjoyed. She reported when asked about what had encouraged her to be a mentor on *Qudwa*:

> Sharing knowledge is something that I enjoy. I wanted something pleasant in my life other than my work, you know. I always work on my computer and coding, I needed another aspect in my life related to my field.*

The case with Qudwa14 was different. At the time I approached her with the concept of *Qudwa* she was not feeling content with herself. She felt unfocused and seemed to forget a lot. She explained:

> There is a study of someone, I forgot his name, I think it is Jordan Hopkins, it said that mentoring helps mentors in reducing the decline in brain performance and abilities. The time when you contacted me, I was forgetting a lot and unfocused. That's why I wanted to take advantage of this opportunity of mentoring to increase my brain functionality. That's one of the reasons. It was not the best time of my life. I thought of doing something that could take my mind off it. Something that would help me feel better about myself. Wow, I did something good … something like that, you know.*

She added that the mentees' questions reminded her of some of the knowledge that she had forgotten she had. She was thankful and appreciative of the knowledge she had; she shared her experience with her cousin, who was suffering from the same problem of feeling useless.

Continuity of Qudwa

Three mentors wished for *Qudwa* to continue and grow. Qudwa8 suggested improving *Qudwa* in ways to reduce pressure on the system, to ensure its sustainability and continuity. Qudwa5 and Mentee23 shared the thought of *Qudwa* getting larger and reaching a higher number of girls. Qudwa2 liked the idea of getting help from people from your own country and commented:

> I think the effort you've put into *Qudwa* is huge and I hope the project grows bigger. The channel is amazing, to know that there are people available in one place and that you can communicate with them in any way you want. We

are used to going on the internet to seek help from people in other countries, it's nice to see people available here from our country.*

Impact and influence

Through the interviews, impact and influence were evidenced in different situations. While mentors felt the vagueness of their impact on the mentees, mentees showed different levels of how their participation in *Qudwa* had had an impact on them. In addition, peer influence was noted among participants.

Vagueness of impact

Due to the mentees' low interactivity and some lack of appreciation in the WhatsApp groups, three mentors felt the vagueness of their impact on the mentees. Qudwa5 clearly said that she did not know whether the mentees had benefited from her or not. Qudwa14 assumed that she was not helpful to her mentee because the mentee stopped responding. Qudwa2 shared the same concern when she was asked about her interaction with the mentees. It was confusing for her not to know whether the mentees were benefiting from her or not. She explained that the lack of interactivity might be because of her style in conversing and that she did not know how to approach the girls. The idea of anonymous feedback during the mentoring relationship would help her to know whether she is doing the right thing or not:

> The feedback idea would allow her to talk about the problem. Maybe in the conversation, there is a problem, that's why she doesn't feel she benefited from me … feedback is the best way to know if we are on the right track or making them even more confused … I'm not saying that thanking me is a crucial point to me, but that's something I noticed, if they didn't interact, I don't feel that they had benefited.*

On the other hand, two mentors believed that the least they could give was sharing their experience with the mentees. Qudwa2 expressed that what she shared with her mentees was experience, something that was not taught anywhere. Qudwa8 explained that she had trouble with her mentee during a call because the mentee was not interacting with her, so she decided to talk about her life/work experience:

> I believe that telling your experiences to others is beneficial. Since I couldn't advise her on what to study, why don't I tell her about my experience in life? … I felt that I didn't give her much but somehow she benefited from what I said.*

Two mentors who had the chance to experience the mentoring through audio calls felt the appreciation of their mentees. Mentors who were in contact via WhatsApp varied in their answers. Qudwa8, who had two audio calls with two different mentees, described them as two

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different personalities, and felt their appreciation and gratitude. Qudwa2 was affirmative that she did not receive any kind of appreciation from the mentees in the WhatsApp group, which bothered her; on the contrary, she felt sincere appreciation from the mentees she talked to through audio. She was bothered by the sudden halt of interaction in the WhatsApp group:

> There is no doubt there was no appreciation … If you go back to the conversation, it's open without an end, my reply was the last thing. I can't tell if she's with me on the opinion or opposes me. There was not even a thank you for the opinion, the subject is still open. Ending the conversation with a thank you is enough for me.*

Qudwa5, who only experienced mentoring through WhatsApp, reported that she felt appreciation from her mentees and could not recall if they did not as it was not an important issue to her. Qudwa14 at the beginning did not remember if there was any lack of appreciation, but then she recalled that she felt appreciated from the audio call but not from the WhatsApp group. Because she volunteered to participate in *Qudwa*, the lack of appreciation or feedback did not annoy her. She reported that the reason for that was the nature of the communication methods:

> It's a question and answer, it's not a continuous relationship like in an audio call.*

Different levels of impact

Even though mentors felt confused regarding their impact, interviews with mentees showed different levels of impact. Mentee17 changed her major after she was in contact with a mentor; while her decision was not only based on her talk with her mentor, it gave her reassurance that her decision was right for her. Mentee13 participated in *Qudwa* to know the differences between the computing fields. She stated that her participation had a positive outcome and that she understood the main differences between computer fields.

Some mentees through the interviews showed their appreciation and the positive impact *Qudwa* had on them:

> *Qudwa* had a positive impact on me, I'm excited to graduate school and apply to universities. She did a great job with us; other people might say that they are busy. She gave us from her time, she answered lots of questions that were on my mind.* – Mentee23

Peer influence was another form of impact that was noted from the interviews. Mentees shared their experience on *Qudwa* with their peers and advised them to join and participate. Mentee5 shared her experience with a friend who she thought needed guidance

and help. It has been found through the analytics of *Qudwa* that the search term of "biomedical engineering" was entered, which is the field of her friend.

Mentee23 told her friends that she would have a call with a mentor. She was asked about how they responded:

> They told me that I should give them my feedback after the meeting. When you are done with the meeting, tell us, we might want to do the same … After the meeting, I had a group call with them on Snapchat and I told them what I asked and that she was really nice and she gave me more than the time we scheduled and she was talking to me in a friendly way, not like she was years older than me.*

She also shared her experience with her younger sisters, who were upset that they did not know beforehand about the meeting because they wanted to join the meeting with her.

Mentee17 told her sister, who specialised in neuroscience, about *Qudwa* after she saw a mentor on *Qudwa* with the same specialty. She had shared her experience and the information she learned from her mentor with her friends too. Mentee13 also mentioned that she shared her experience with one of her friends.

Another form of indirect impact was visible from browsing the mentors. Submitter1, who did not contact any of the mentors, stated that she was amazed by the qualifications of the mentors, while Mentee17 did not expect that there were Saudi females in these positions or workplaces.

The indirect influence reached the mentors as well. Qudwa5 expressed her pride in being part of *Qudwa* with the group of mentors. Qudwa14 mentioned that she had browsed one of the mentors' profiles because she thought that it intersected with her field. She added that she had browsed other mentors' Twitter accounts.

Being in a WhatsApp group also had a peer influence on the mentees. When they were asked about their reasons for not leaving their groups or why they were inactive in the groups, some mentees mentioned that they benefited from the other mentees' questions and discussions. Mentee23, after her call with a mentor, asked to join the WhatsApp group of that mentor. She thought that she might benefit from the questions of other mentees. Although she found the call better in expressing herself clearly than the WhatsApp group, she admitted that she had benefited from the group. Submitter1, who did not participate in *Qudwa*, said that if she was to choose a way of communication, she would choose a WhatsApp group. She believed that being in a group was more beneficial because others might ask questions or open discussions that did not cross her mind. Mentee13 also agreed that being in a group was favourable because of the presence of others.

On the other hand, Mentee19 had only asked one question to the mentor in the group because most of the questions she had in mind were asked by others. Mentee17, although she was not in a group, mentioned how being in other WhatsApp groups (related to her study) with her peers was helpful for her because they shared useful things. She thought that promoting in such groups would attract other girls to *Qudwa*.

Differences between mentors and mentees

There were differences in the experiences of mentors and mentees with *Qudwa*, differences in how they perceived their mentoring experience. As mentioned earlier, there was variation in the perception of the level of impact between the mentors and the mentees. There were differences in their opinions about the communication channels, relationship levels, type of help that was expected and my role as the intermediate person.

Communication channels

All the mentors agreed that they preferred audio communication in comparison to textual communication. Qudwa14, who was in contact with mentees via both methods, mentioned that she preferred audio calls. She added that she used the voice notes feature in WhatsApp to express her thoughts easily. Qudwa2 also mentioned that she did not prefer WhatsApp communication. She believed that WhatsApp gave her flexibility in time, but would be more suitable for technical questions (coding and programming). She thought that audio calls helped in understanding the mentees better. Qudwa8 reasoned that her choice of preferring audio communication related to the age of the mentees and to the critical decision they were making. Qudwa5 shared the same concern as Qudwa8. Even though she did not experience mentoring in *Qudwa* through audio calls, she believed that an audio call would be more suitable for discussing critical decisions:

> WhatsApp is good as a first communication … I believe that there must be vocal communication, but it depends on the girl of course. If she doesn't have big concerns, she might use WhatsApp. But if she has a lot of questions and concerns and she wants to have a one-to-one conversation, I think a call would be better.* – Qudwa5

Three of the mentees (who were interviewed by phone) agreed with these mentors and favoured audio calls. One mentee (who was interviewed by phone) preferred WhatsApp group communication. As mentioned earlier, five mentees who were asked for phone interviews preferred to communicate textually through WhatsApp.

Mentee5 preferred audio calls because what she wanted to discuss with the mentor was personal and she thought that sharing it with a group of others was not the best way. Mentee23, who experienced both methods, said that she preferred audio calls. She later joined the WhatsApp group of the mentor to gain more benefit from the discussions.

On the other hand, Mentee17 changed her request several times because she did not know what to expect. In the beginning, she requested an audio call with Qudwa12 and to join the WhatsApp group of Qudwa5. After she was added to the WhatsApp group of Qudwa5, she requested to change her request for an audio call with Qudwa12 to joining her WhatsApp group. She did that because she thought the groups would have many girls, while it had only two or three girls at that time. She also mentioned that she was not confident and thought that she "is not good with people". Later, she requested an audio call with Qudwa12. Through the interview, she mentioned that she liked audio calls more than the WhatsApp method. She added that she was not confident at the beginning of audio calls, but later on felt more confident because of the way Qudwa12 was talking to her. I asked her if she felt shy or embarrassed asking questions and she replied:

> Honestly yes, at the beginning, but then I felt confident and more comfortable. Because she was comforting to talk to and I felt that she had the information that I need.*

On the contrary, other mentees preferred textual communication through WhatsApp. Mentee13 (interviewed by phone) thought that an audio call would be formal and chatting through WhatsApp gave her flexibility in answering and arranging her thoughts. Other mentees who were interviewed through WhatsApp suddenly stopped responding, which made the interview came to an end without covering the discussion points. Mentee9 explained why she chose to communicate with the mentor through WhatsApp:

> It was one of the easiest applications provided and it has the advantage of sharing media like voice notes.*

When I asked her why she did not choose to have an audio call since she favoured the voice notes feature, she replied:

> I did not like the idea of being committed to each other through a call when I don't know how long it will last. We can chat and whenever we have time, we respond.*

The other mentees did not provide a chance to complete the interview to ask them about the communication channels. Submitter1 through the interview said that if she had to pick a method of communication, she would pick the WhatsApp group because of the benefit she would gain from the questions and discussions by others in the group.

Level of the mentoring relationship

Mentors put more emotions into their relationships with their mentees than the mentees themselves. Mentees who said that they benefited from their mentoring relationship thought that they were satisfied and had what they needed. On the other hand, mentors felt that they needed more time to understand the mentees and help them.

Qudwa8 emphasised the importance of understanding her mentees and that was why she insisted on the use of audio communications because it showed feelings. Qudwa2 mentioned that the discussions with the mentees should be longer. She needed to understand them and understand what they were thinking about. She believed that this understanding came from conversing for a long period of time and through many sessions. She also suggested sending a set of questions to the mentee before the meeting; these questions would help her get to know the mentee better and know how to approach her and help her. Qudwa14 wished for a continuous relationship with her mentees. She believed that she was putting effort and feelings, and that she would like to keep the relationship going. Qudwa5 reported that she tried to understand her mentees by repeating their questions. She wanted them to be more precise in asking questions or describing their concerns. This way she would be able to help and guide them.

Two mentors felt a difference in the way that mentees looked at mentoring in comparison to them. They expressed their thought when the discussion was about passive mentees. They thought that the mentees were using the mentoring via WhatsApp group as a "reference" or a way to "collect opinions":

> I felt like she's collecting opinions, she has the right to do that of course. I think she has addressed more than one channel to collect information from them and then she will decide, that's why there is no response from her side. I felt that they did not care.* – Qudwa2

> Maybe she thought that a group is like a reference to her and that she can go back to it anytime. I don't know.* – Qudwa5

From the mentees' side, they reported that the level of the relationship was enough for them. They were asked if they needed more commitment or another session with their mentors, and they were satisfied with what they had:

> Honestly, it depends on the situation. In my case, it was enough. For example, if I didn't have a plan before my use of *Qudwa* and I had no idea what I wanted to do, I think I would need more help. In my case, as I said, I just needed to be sure of my decision, so when I talked to the mentor, she gave me input and inspired me. I felt that this was enough for me. I just needed to learn about someone successful in that field.* – Mentee17

Type of help

The mentors were careful to help the mentees think about their options and not to give them direct answers or guide them in a specific direction. Qudwa2 noticed that some of the mentees were seeking someone to make the decision for them and give them direct answers on what major was suitable for them:

> I am very careful not to guide but to help think, I help to choose the right option for that person. I know that the goal was to encourage them into STEM, but I think the goal at the end is to help that girl to choose the right place for her.* – Qudwa8

> Some of them were not convinced, some of them wanted specific answers. My first call was like that, she was very confused and wanted to learn more about the fields, but she wanted a specific answer on what field suited her the most. I don't know her. I gave her all the options and what is the basis of choosing each field. Then she can make the decision, no one else.* – Qudwa2

Three mentors did not expect the kind of questions and discussions they received from their mentees. Qudwa5 was faced with some family problems from her mentee and she clearly explained to the mentee that she could not interfere in any family-related issues. Qudwa14 and Qudwa2 expected different kinds of discussions, work-related discussions. Qudwa2 wanted them to ask her about the job itself, her role as an employee and what was required from her, and she stressed that "getting a job is not the end"*. On the other hand, Qudwa14 was surprised that the mentees were asking about the future of a person with a computer science degree, as she thought that this kind of knowledge should be known by now. She thought it was unexpected that the mentees had a lot of questions about university admissions and requirements. She believed that everything was on the internet.

Two mentees who expressed that they did not benefit from *Qudwa* in the way they expected had had different expectations than what *Qudwa* provided. Mentee29, who was a passive member of a group and then left the group, was expecting that she would be provided with some training or courses. Mentee21 said she left the group because she wanted someone to tell her what field suited her the most:

> No, the reason is that I asked my questions and the mentor responded. Other than that, I wanted someone to guide me in which is best for me … My goal with *Qudwa* was to find someone to tell me based on my interests and my abilities that this field suits me.* – Mentee21

The intermediate person

Both mentors and mentees were asked about their opinion of my role as an intermediate person between the two parties. The mentors were thinking from a professional point of view

and how the role required time and effort from my side, while the mentees loved the human touch of *Qudwa*. Qudwa8 was thinking of the continuity of *Qudwa*, so she suggested turning *Qudwa* into an automated system to ensure its sustainability:

> To sustain *Qudwa*, there is pressure on you because you handle every request. If there would be a way that you supervise and the two parties communicate directly.*

Qudwa5 suggested that mentors handle the contact requests themselves. As a web developer, Qudwa14 analysed the intermediate role. She added that people in Saudi Arabia prefer WhatsApp as an easy and fast method of communication:

> Whatever you do, the system can do it too. I don't want to be rude, but your role can be replaced … I'm looking at it from the standard ways in web applications, there are no humans in the middle, but there are support systems … For us here in Saudi, I think people use WhatsApp as the fastest way of communication … The standard is to have a support system and you send an email, but here they won't send an email if there is a WhatsApp number.*

Mentee17 assumed that the role of *Qudwa* would end after she got connected with the mentor, but she admired that the system cared about her. She added that: "It's nice to have a person to talk to, not a website"*. Mentee23 believed that the intermediate person role was very important in her case. She reported that she had submitted the form out of curiosity, but she got excited after the system got in touch with her. In addition, she thought that people prefer talking to humans rather than systems. Mentee13 was surprised that there was a person behind *Qudwa*, she thought it was an automated system.

Cultural factors

The interviews showed that the culture had an impact on the interaction of participants in different ways. There was an emphasis on talking and getting help from Saudi females. There appeared to be a cultural problem of recommunicating or following up with someone older or of a higher position.

Female Saudi mentors

The emphasis on the need for mentors to be Saudi and to be female occurred on several occasions. While talking to female strangers is not a widespread concept in Saudi, talking to a male stranger in most Saudi societies is not acceptable. Qudwa8 talked about one of her audio online meetings with a mentee where she sensed that the mentee was uncomfortable and had reservations during the call. Qudwa8 felt that the mentee got nervous and tense when some of her family members came around while she was on the call. The mentor highlighted that

maybe talking to a male mentor would make her even more uncomfortable or cause her some problems with her family.

Mentee23 on her submission request added that she preferred her mentor to be a female. She clarified why she said that by saying that it would be more comfortable for the girls. Mentee21 in her WhatsApp interview reported that she needed to feel comfortable knowing all the participants in the group were female. When I asked her to clarify, she responded through WhatsApp:

> I want to be sure that all the participants in the group are female + they all have joined the group to benefit.*

On the other hand, the fact that the mentors were preferred to be Saudi stemmed from the need to find someone who lived in the same circumstances. Qudwa14 during her interview mentioned how she had looked for a female in the electrical engineering field to help and guide her. She highlighted that the career options for men were clear and known, but what about her options as a Saudi woman?

> If there was *Qudwa* at that time I would definitely have used it and especially if she's a female! I would ask her what will we study? What do you do? Where can I get a job? … for example, here in Saudi I know what an electrical engineer does when he graduates, he gets employed in factories and other places, but females? It would be nice to have a female from the same environment, with the same options, the same challenges.*

Mentee13 showed some doubts about the mentors. From the profile pictures of some of the mentors, she thought that they were not Saudi or that they were Saudis living abroad. She clarified that their experience would be different because she intended to study and work in Saudi Arabia, which is why she thought that she might not benefit from their experience.

Other cultural factors

It appeared that the cultural background of the participants affected their participation in different cases. Qudwa8 drew attention to the differences she recognised between the two mentees she had audio meetings with. She thought that the first mentee was more interactive with her during the call, while the second was quiet during the call and cautious. She believed that the cultural differences between the two mentees had an impact on their interactivity. The first mentee was from a more developed region in Saudi Arabia and the second mentee was from a small city. She explained:

> I could tell from the backgrounds of the girls that there were some cultural differences. The first girl I talked to on the internet was from the eastern region, she was aiming to study at a private university, her English language

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level and knowledge were excellent, she had an internship, so her culture or society level was different. The other girl had just graduated from school and was from Taif, she had some social reservations, you know.*

The interviews showed a cultural problem or issue: fear or embarrassment at communicating or following up with older individuals or those of a higher position than themselves. Qudwa8 mentioned that she forgot about her mentee and that her mentee did not follow up with her or remind her. Qudwa8 referenced this to the cultural problem of not following up with people or organisations because they think less of themselves just because they are younger or of a lower position. This issue happened twice to Qudwa8. Through the interview Qudwa8 rementioned this problem when she asked her mentee to add her on LinkedIn to provide her with courses, articles and organisations regarding the field she was interested in. She explained that she was willing to help and give her mentee the resources she needed if the mentee showed interest by taking one step towards her. Up to the time of the interview, she had not received any connection request from the mentee on LinkedIn.

Mentee19 was asked about how to develop *Qudwa* and she wanted the mentor to talk about her struggles and the difficulties she faced, give them advice and guidance. I told her that she had the chance to ask the mentor herself in the group and she said that she was busy with university interviews and applications and would ask her after she was done with them. Submitter1 did not submit a form to contact any mentor because she wanted to be ready before she talked to the mentor. She gave a sense of exaggerating the status of a professional. She described her previous attempts to get answers from professionals on social media platforms as failed attempts. Although she wanted to learn more about the field that she was interested in and she believed that *Qudwa* could help her, she thought that she needed to be prepared beforehand.

On the other hand, Mentee17 and Mentee23 were astonished by the way the mentors were talking and addressing them. Mentee17 had some reservations about talking to her mentor using audio because she thought that she was not good with people. After the call, she described her mentor as "very friendly and very nice"*. Mentee 23 was surprised that her mentor was talking to her as if they were of the same age.

Qudwa and mentors' daily activity

Three mentors who had repetition of questions in their groups were asked about how they felt regarding this situation. The three mentors reported that they were not interrupted or distracted by the use of WhatsApp during their day. They all stated that they answered questions and communicated with their mentees during their free time:

Honestly, it wasn't a big effort, it was just a period of time, that didn't affect my work time, even on WhatsApp. Whenever I felt I had free time, I replied to them.* – Qudwa2

Qudwa5 and Qudwa14 were not bothered by the repetition, but Qudwa2 was annoyed about the repetition because the mentees suddenly stopped interacting. She expressed that she would not mind repeating her answers if she had seen responses from the mentees in the group:

Yes, it bothered me, and what bothered me the most is that the interaction stopped. If there was any kind of interaction, then I wouldn't have a problem with repeating my answers, information or discussions, but they stopped the interaction and it felt like they reached a point where they wanted someone to decide for them. They suddenly stopped. I don't know what happened to them. Honestly, this is the thing that bothered me most.* – Qudwa2

Qudwa2 and Qudwa14 suggested sharing the answers to common questions asked by the mentees. Qudwa14 suggested that the answers would be written as a collaboration between *Qudwa*'s mentors. Qudwa2 proposed that any liked or favourited answer by the mentees could be shared on *Qudwa*.

7.3.9 *Social media announcements*

This section presents the analytics collected from the promotions on Twitter and Instagram, followed by an analysis and reflection.

Twitter

The Twitter account had a total of 352 followers. The promoted tweet which presented the animated video about *Qudwa* had a total of 51,074 impressions with 82 clicks on the website link (Figure 7-6). The video had 8,900 views, 6 retweets and 48 likes (Figure 7-7).
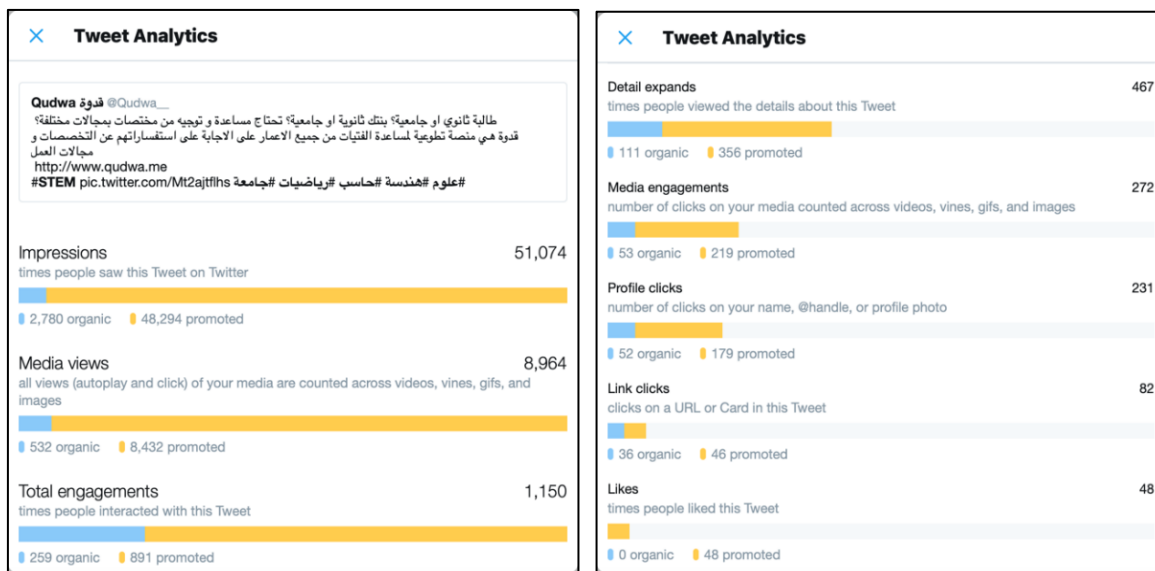
Figure 7-6 Twitter analytics

Figure 7-7 Number of views of the promoted tweet

Instagram

The Instagram account had 319 followers. The promotion on Instagram resulted in 1,828 profile visits and 1,554 website visits (Figure 7-8, left). The post was bookmarked 82 times and got 51 likes, and the video on the promoted post was viewed 9,153 views (Figure 7-8, right). Insights from Instagram provided details on the location of the audience, their age range and gender (Figure 7-9). The insights showed that most were from Riyadh (29%), followed by Jeddah (20%). Most were female (94%) with 45% of them in the age range 18–24 years (Figure 7-9).

Figure 7-8 Insights from Instagram on the number of visits and views
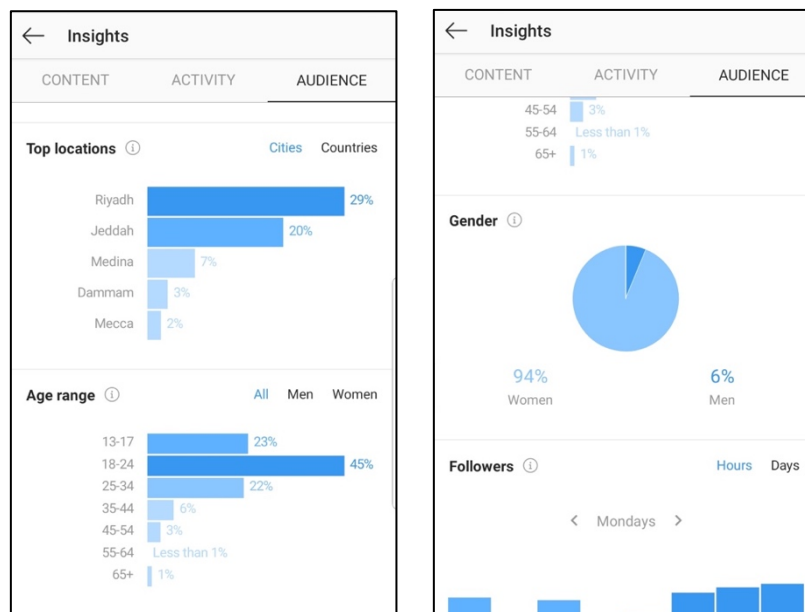
Figure 7-9 Insights about the audience on Instagram

Promotion on social media

The number of followers was almost the same on both platforms, the Twitter account with 352 followers and the Instagram account with 319 followers. The views of the promoted animation video on Twitter numbered 8,900, which is close to the number of views on Instagram which reached 9,153. The insights from both promotions showed that audiences on Instagram were more interactive with the promotion than on Twitter. The audience on Instagram who visited the account profile numbered 1,828, in comparison to the 231 profile clicks on Twitter. The number who visited the website from Instagram was 1,554 in comparison to 82 clicks on the link to the website on Twitter.

The post-study survey showed that most mentees who knew about *Qudwa* came from Twitter (43%) in comparison to 38% who knew about *Qudwa* from Instagram and 14% from WhatsApp. Most of them also suggested Twitter as a helpful method for promoting *Qudwa* (44%), while Instagram received 17% and WhatsApp received 31%.

Mentee5 in her interview, when asked about which channel was best for promoting *Qudwa*, mentioned that Instagram was not the right place to look for help regarding her studies:

> I think Twitter because it is more suitable for *Qudwa*. I don't think I would go for Instagram to search for things like *Qudwa*, if I wanted something like this I would go to Twitter.*

The insights from the social media contradict the results of the survey. The insights showed more interaction from Instagram than from Twitter. Participants might have found Twitter a more suitable platform for a service like *Qudwa*, but their online availability or online presence on Instagram was greater than on Twitter, which may explain the higher interaction from the Instagram promotion than from the Twitter promotion.

7.4   Discussion

In this section, I present the evidence from the findings on how *Qudwa* accomplished the design requirements presented earlier in Chapter 6. I also discuss the automation and improvement of *Qudwa*. A more detailed and overall discussion will be presented in the next chapter.

7.4.1   *Design goals*

The findings have shown that *Qudwa* achieved the design goals. From the interviews and survey, it was noted that the flexibility and control features in *Qudwa* were highly appreciated and favoured by the mentees. Some mentees needed to be prepared before contacting a mentor, while others contacted more than one mentor. *Qudwa* being mentee-initiated helped in coping with the different personalities and needs of mentees. Giving the mentees the flexibility and control in their mentoring relationships showed that the majority of mentees (81%) were satisfied with the level of their relationship. In addition, the interviews showed that mentors felt the need for a stronger relationship, while mentees were contented and more comfortable with what they had experienced on *Qudwa*. On the other hand, the variety of personalities and needs of mentees also influenced in the decision on a communication channel. Personal preference was the basis of the selection of communication channel for some mentees. Some preferred textual communication for ease of use, due to their shyness or

lack of self-confidence and to feel less formal, while others showed that the selection of the communication channel depended on their needs. For specific and more personal help and guidance, they would choose a one-to-one audio call. For more general help, they would choose to be in a WhatsApp group. The findings showed that some mentees communicated with the same mentor through different channels.

The second design requirement was visibility. Visibility was evidenced in different aspects. The survey results showed that the majority of mentees (81%) stated that *Qudwa* had raised their awareness of female STEM professionals in Saudi Arabia and that 43% of the mentees visited the mentor's social media accounts and found them beneficial. The findings showed that mentees had shared their experience on *Qudwa* and their surprise at such mentors with their peers in general. They had also recommended *Qudwa* to specific individuals they knew, either because they believed that *Qudwa* would be beneficial for that specific person or they found a mentor who was specialised in that individual's field or a field that she wanted to study. This gives proof that the mentees had widened their knowledge and awareness of different mentors in different fields. While *Qudwa* intended to create visibility of the mentors among the mentees, the findings showed that mentees were pleased with the visibility of knowing that others of their age shared their concerns. The results showed that being in a group with others was beneficial for them because they believed that others might discuss things that did not cross their minds. Visibility also reached the mentors. Some browsed other mentors' profiles and visited their social media accounts. Others showed pride in being among such a group of mentors and would get in contact with other mentors.

Qudwa was designed to fit within the participants' daily internet activities. The survey results showed that the mentees did not have any problems with the communication channels. Ease of use was the most common reason why mentees chose their communication channel. Through the interviews, mentees and mentors described WhatsApp as an "easy" and "fast" method of communication. Mentors agreed that *Qudwa* was not a burden and that it fit well with their daily activity and work schedule.

The final design requirement was the trusted connection represented by the human presence in applying the Wizard of Oz concept. The reason behind this design requirement was to ensure that mentoring was conducted as it should be and to clear up any misunderstandings. The findings of the survey reported that almost all the mentees (90%) found the presence of an intermediate person helpful. The findings showed that the intermediate person in *Qudwa* was helpful and needed in different situations. As expected, some mentees needed to understand the concept of *Qudwa* and others needed direction in which mentors to choose, while others had different expectations. Some mentees liked the

idea of a caring person and indicated that the presence of a human who was in contact with them had encouraged them to continue their participation in *Qudwa* compared to a fully automated system.

7.4.2 *Improvement of Qudwa*

The design of *Qudwa* was dependent on a human who acted as the system. While the idea of a human presence was favoured by the mentees and fulfilled the design requirement of a trusted connection, the findings showed that some of the tasks were preferred to be automated or delegated to mentors. To ensure the sustainability of *Qudwa*, the mentors suggested some modifications including automated scheduling, transferring the process of handling contact requests to the mentors and collaboration between mentors to provide answers to commonly asked questions. These suggestions stemmed from the mentors putting themselves in my place and their desire to lower the burden on them and me (who acted as the system). On the other hand, 90% of the mentees were satisfied with the human presence and thought of it positively. It is reasonable to think that the lack of understanding by the mentees of the professionals' workload did not widen their thinking about the burden caused by handling some of the tasks manually. Manual scheduling and handling of each contact request were thought of by the mentors as a burden and time-consuming to me. If mentors handled their own requests, it would help them to get to know their mentees better by asking them questions before the e-mentoring session. Even though mentors were not bothered by the repetition of questions, some suggested that collaboration between *Qudwa* mentors could result in the answering of common questions. Others suggested that answers that were *liked* by the mentees could be collected on *Qudwa*. Collecting the commonly asked questions or favoured answers publicly would provide more time for mentees to schedule mentoring sessions with different issues to discuss than those provided in the *Qudwa* repository. In addition, it would reduce the pressure on the mentor to answer the repeated questions, which might result in boredom or a lack of enthusiasm in answering and interacting with their mentees. On the contrary, the mentees disagreed with a question-and-answer format of *Qudwa*. The findings of the survey reported that 81% showed disagreement with turning *Qudwa* into a Q&A website. This could be a reaction to their difficulty in finding someone who answered their questions adequately instead of reading blogs and informational websites or asking professionals who answered briefly or not at all.

An integration between what the mentors suggested and what the mentees wanted would result in keeping *Qudwa* as is in terms of the e-mentoring relationship and communication methods, along with adding a section for commonly asked general questions

to lessen the burden on mentors. Regarding the automation of *Qudwa*, some tasks will be automated in an improved version of *Qudwa*. These tasks include handling *Recommend a mentor requests*, scheduling meetings and emailing confirmations for the meetings. Going back to Table 7-1, this means that all the tasks that were designed to be completed by the system will be automated except for one task, which is handling mentees' requests. Mentors suggested that they could handle the requests of mentees themselves. In their opinion, it would help them learn more about their mentees. The human side of *Qudwa* represented by the admin will still be available since the mentees favoured the existence of a human on a website. The admin will help through the website and monitor interactions to make sure everything goes well.

7.5   Summary

In this chapter, the deployment and findings of *Qudwa* have been presented. The deployment, which lasted for two and a half months, showed variation in the findings in different aspects. There was variation between mentors and mentees regarding the preferred communication channel and the level of the mentoring relationship. There was variation as well between the mentees, which was affected by their personalities, their needs and their cultural background. The chapter concluded with how *Qudwa* will be improved. Some changes are clear and obvious, such as the automation of scheduling meetings and sending confirmation emails to participants. Other changes were suggested by the mentors, such as building a repository for frequently asked questions and moving the task of handling requests from the admin's responsibilities to the mentors' responsibilities. The main design of *Qudwa* will remain the same, based on un-platforming and short-term relationships between mentors and mentees.

Chapter 8 Discussion and Conclusion

8.1   Introduction and Overview

This thesis has presented how I explored e-mentoring for female teenagers and young women in Saudi Arabia with the purpose of encouraging them to seek careers in STEM fields and increase their awareness of Saudi female professionals in STEM. This research had three research questions: first, what is the potential for applying a STEM e-mentoring program for teenagers and young women in the Saudi context; second, what are the factors that contribute to designing a STEM e-mentoring system for teenagers and young women in the Saudi context; and, finally, how to design a STEM e-mentoring system for teenagers and young women in the Saudi context.

The absence of mentoring in the Saudi context and similar contexts directed the exploratory nature of this research. Four studies were conducted to answer the questions of the research. Chapter 4 described the pilot study (Study 1), which was a deployment of a structured STEM e-mentoring design. The cultural factors of Saudi Arabia were the main factors considered in this study. The pilot study aimed to explore the potential for applying a STEM e-mentoring program for teenagers and young women in the Saudi context. The results of the pilot study led to carrying out two co-design studies (Studies 2 & 3) presented in Chapter 5. These co-design studies aimed to identify the factors for designing a STEM e-mentoring for teenagers and young women in the Saudi context. Chapter 6 presented four design requirements: 1) flexibility and control; 2) visibility; 3) integration of e-mentoring with daily internet activity; and 4) a trusted connection between mentors and mentees. It described the design of *Qudwa. Qudwa* was designed based on the findings of the studies conducted in Chapter 4 and Chapter 5 and the lessons learned from previous work on structured e-mentoring. It was designed to give mentees and mentors more flexibility and control in their own e-mentoring relationships. *Qudwa* was designed to be embedded in their daily internet activity, instead of pulling them into another space, by using existing social networking platforms. Chapter 7 presented the deployment and evaluation of *Qudwa* and concluded with improvements to the design.

In this chapter, I revisit the research questions and reflect on the work conducted. Several discussion points have emerged from this research that future research should take into consideration. These discussion points reflect the Saudi context and the e-mentoring design. This research was context-specific, so findings related to Saudi Arabia and similar contexts were developed. The first section reflects on the first research question of this research, to examine the potential for e-mentoring in Saudi Arabia. The second section

revisits the following two research questions related to identifying the factors and designing of e-mentoring. It explains how the inclusion of co-design activities shaped the redesign of e-mentoring. It further discusses the idea of unplatforming and augmenting existing social media platforms. I talk about the evaluation and measurement of e-mentoring and report on the absence of mentors in the design process. Finally, I conclude with design implications, future work and limitations of this research.

8.2 The Saudi Context

One main aspect of this research was the context of Saudi Arabia. The first research question of this work was to explore the potential for applying a STEM e-mentoring program for teenagers and young women in the Saudi context. While the findings of this research showed that the design requirements were less affected by the cultural factors and more by the age group, several discussion points have emerged that address the potential and need for e-mentoring in Saudi Arabia and are worth further looking into.

8.2.1 *The demand for mentoring*

As discussed earlier, the lack of mentoring in general in Saudi Arabia is an issue that has been discussed rarely in the literature. In comparison to the developed work around mentoring and e-mentoring in other contexts such as the USA and Europe, few articles were found around traditional mentoring in Saudi Arabia (Abalkhail and Allan, 2015; Al Qahtani, 2015; Fallatah et al., 2018; Ghawji et al., 2017; Sattar et al., 2017; Shukri and Leil, 2017) and none were found around e-mentoring in Saudi Arabia. These articles pointed to the need to initiate traditional mentoring programs in Saudi Arabia in different fields. They argued that the success of mentoring programs and initiatives in other contexts provided a motive for replicating and developing mentoring programs and initiatives in Saudi Arabia. One main contribution of this work is exploring the requirements for and consequently conducting the first documented e-mentoring program in Saudi Arabia. Even though the work conducted in this research was on a small scale and for a limited period of time, the results of all four studies show potential and demand for the concept of mentoring.

It is important to highlight that the participants in Chapter 4 and Chapter 5 came from diverse backgrounds and yet they showed interest in and demand for e-mentoring. In Chapter 4, the findings showed that the need for mentoring was not limited to girls with parents who had low levels of education, but was also found in those with parents who specialised in STEM or were highly educated. In Chapter 5, the co-design workshops were conducted with two groups. The first group (Study 2) were undergraduates studying at community colleges

who came from low socioeconomic backgrounds and the second group (Study 3) were high school students from higher socioeconomic backgrounds as compared to the participants of the first group. The themes that emerged from the thematic analysis of data from Study 2 were not different from the themes that emerged from the data from Study 3. Participants from both studies, who came from different socioeconomic backgrounds, emphasised their need for mentoring. The holistic manner of thinking about e-mentoring exhibited by participants in Chapter 5 demonstrated high levels of maturity and interest in e-mentoring. This demand came also from visitors with different backgrounds requesting non-STEM fields and mentees of older age groups.

In Chapter 7, while the backgrounds of the participants were not collected, it was interesting that the visitors to *Qudwa* were looking for mentors in fields other than STEM fields. The findings showed that 17 *Let us help* submissions were requesting fields not supported by *Qudwa* such as finance, arts, translation, fashion design, law and business. Although *Qudwa* was designed to support and guide females who are graduating from high school (or younger) and undergraduates, to guide them through university applications and career paths, the findings showed that there were participants who were older. Older mentees sought knowledge about fields that they were not familiar with. This is consistent with the findings of previous work that reported that participants in Saudi Arabia had positive thoughts about mentoring and believed in the values and benefits of mentoring (Al Qahtani, 2015; Fallatah et al., 2018; Sattar et al., 2017).

The findings of this research reported different levels of impact on the mentees. In Chapter 4 and Chapter 7, after their participation in the studies, mentees showed higher levels of awareness of available STEM careers and professional Saudi women in STEM, and some mentees took action after their participation. Three years after Study 1, I followed up with some of the mentees and one mentee said that after she participated in the pilot study, she was reassured about the field she wanted to study and that the e-mentoring experience had widened her perception of career options. Another mentee who joined *Qudwa* needed to make a decision about changing her study major. While her decision was not only based on her talk with her mentor, it gave her reassurance that her decision was right for her. Therefore, it is fair to say that *Qudwa* (as discussed in Chapter 7) was a successful implementation of e-mentoring in Saudi Arabia in terms of increasing awareness and leading to action, even though this was not measured in terms of effectiveness and there was no long-term assessment.

Qudwa broadly confirms Sulphey and Allam's (2017) argument that the success of traditional mentoring programs in other countries will have the same impact and success in

Saudi Arabia. The lack of mentoring and e-mentoring in Saudi Arabia contributed to the demand and success of *Qudwa*. Literature around mentoring and e-mentoring in Saudi Arabia and similar context is scarce, and further explorations and investigations on these topics are needed to develop a full understanding of the area. Although this research aimed to tackle the issue of low participation of females in STEM in the context of Saudi Arabia, future research in this context should not be limited to STEM or to teenagers and young women, as the findings showed demand from different fields, different age groups and different purposes.

8.2.2 *Lack of Arabic content on the internet*

Instrumental/vocational support, psychological support, informational support and role modelling are the defined functions of a mentor (Ensher et al., 2003; Single and Single, 2005). The mentors in *Qudwa* showed their support through the different functions of a mentor. Mentors provided advice and guided the mentees through which study and career paths they could take. They also encouraged the mentees who found problems in making a choice. Mentors were role models to the mentees; they inspired and shared their previous experiences and challenges with them. What was surprising to the mentors was the kind of information needed by the mentees, which the mentors considered common knowledge and basic information. Mentors attributed this behaviour to the lack of Arabic content on the internet.

In a recent study examining information-seeking using the Saudi Digital Library (SDL), which is a multilingual digital library, it was reported that finding Arabic resources for academic purposes was difficult (Alsalmi, 2019). The participants were asked to perform Arabic and English search tasks, and the results showed that the participants expressed concerns and lack of trust and confidence in the Arabic results in comparison to the English results. They reported that the English search tasks provided more accurate resources, where in the Arabic search task they found challenges in finding relevant resources in Arabic. Due to frustration, some participants had ended their Arabic search task, which is a concerning result because these search tasks might be important for their academic purposes. The study concluded that the lack of Arabic content was one of the challenges experienced by the participants and suggested focusing on and paying more attention to Arabic content (Alsalmi, 2019). Another study in the UAE explored the barriers to using educational videos in the classroom in UAE schools. The study indicated that the lack of Arabic content on the web was one of the barriers (Alawani et al., 2016). Even though the kind of digital Arabic content in the studies of Alsalmi (2019) and Alawani et al. (2016) were different to the kind of

information that the mentees in this research were looking for, they all shared the same obstacle, which is the lack of Arabic content.

Arab internet users constitute 5% of the world's internet users (Abubaker et al., 2015), yet the Arabic content represents less than 1% of web content (Al-Kabi et al., 2018). It is considered to be low-quality content because its main source is inaccurate translations from other languages (Albalooshi et al., 2011) and around 33% of it is generated by social media users (Al-Kabi et al., 2018). In Chapter 7 (Study 4), the mentors suggested collaboration between *Qudwa*'s mentors to build a repository on *Qudwa* to provide answers by professionals to commonly asked questions. This suggestion is similar to the one proposed by Alawani et al. (2016), who suggested progressively creating an Arabic video repository for teachers and learners in the UAE and similar contexts that fit the culture and the requirements of the Ministry of Education.

This finding stressed the need for the creation of a variety of Arabic content on the web. Arab professionals and specialised individuals in all sectors and fields are encouraged to participate in the enrichment of trusted Arabic content on the internet. Another important reason to increase Arabic content on the internet is that online content is used to promote countries economically and socially (Abubaker et al., 2015). Abubaker et al. (2015) reported that one of the challenges that face Arab countries in creating Arabic content is the lack of specialised professionals, while the mentors in this research showed interest in voluntarily collaborating to create a professional repository. This presents a gap between Arab governments and regional initiatives and these professionals who are willing to help. Future research should be undertaken to investigate the scaffolding for creating and increasing the Arabic content on the web, which will be beneficial in mentoring, learning and promoting Arab countries.

8.2.3 *Technology and culture*

Technology use is dependent on culture because culture determines how individuals in one culture communicate with each other using technology (Pookulangara and Koesler, 2011). When designing for a specific context or culture, the norms and culture imply the factors and design implications for that context. Culture in HCI has gained its fair share of studies in the literature (Kyriakoullis and Zaphiris, 2016), with previous studies examining how culture influences the use and design of technology. Saudi Arabia is considered a collectivist country that is mainly affected by culture and religion (Al Lily, 2011; Al-Saggaf, 2011). At the beginning of this research, the cultural factors were the main concern in the design. In Chapter 4, the use of textual communication and the platform Edmodo were design choices to

maintain the privacy of the female participants. The findings showed that mentors and mentees agreed that the platform and the nature of the communication were the major barriers to their experience. The results also showed mothers' approval of the use of other communication methods, including audio and video communication methods, which are not commonly used among strangers in Saudi Arabia. Because of the unfamiliarity of mentoring in Saudi Arabia, parents might have concerns about their daughters talking to professionals they do not know and the involvement of parents was a design choice based on the nature of the culture. Although parents had the opportunity to participate, the results showed that none of the parents did or felt the need to do so. They believed that the rapid changes in technology make it hard for them to control what their children watch or use, so they rely on raising them well and trusting them. This change in the cultural norms of older generations (the mothers) accepting the use of new technologies is likely to be related to the high rate of internet and social media usage by the younger generation (the daughters) in Saudi Arabia, which has led to the rapid adoption of such technologies (Bafakih et al., 2016; Winder, 2014).

In Chapter 7, audio calls were used but none of the participants requested video calls, even though this was one of the available options, because in Saudi Arabia it is considered an uncommon method of communication between female strangers. In addition, Saudi females tend to not share or reveal their personal photos online (Al-Saggaf, 2011; Binsahl and Chang, 2012). WhatsApp was highly used on *Qudwa* and one of the mentors said that the reason is that Saudis use WhatsApp heavily even for professional communications and they find it the easiest way of communication. She also compared her work with non-Saudis and their use of email for professional communication, while when she worked with Saudis they used WhatsApp for professional communication. Technologies that were used on *Qudwa* were designed and used globally, and were not specifically designed for the Saudi culture. In *Qudwa* the cultural factors were relegated to the norms already established for using existing social media technologies. In other words, participants used social media technologies provided on *Qudwa* in the same manner that they usually use these technologies, in a way that was appropriate to their culture.

The design requirements in this research (which are discussed in more detail below) shifted from being culture-specific to being generation-specific. While culture in HCI literature is usually considered a barrier (Kyriakoullis and Zaphiris, 2016), an interesting area of research could look into how people in different contexts use globally designed technology in ways that do not conflict with their culture.

8.2.4 *Why Saudi female mentors*

The nature of Saudi Arabia has guided this research to develop same-gender e-mentoring. As mentioned earlier, segregation between men and women publicly and privately is one characteristic of Saudi society (Al Alhareth, 2013; Al Lily, 2011). Social interaction between men and women is inappropriate, with the exception of professional interaction (Al-Saggaf, 2016). Therefore, it would be unacceptable and a subject for criticism and rejection to create a space where teenagers and young women communicated with male strangers. The difficulties that Saudi women face are different than in other cultures, so presenting female Saudi professionals who have lived in the same circumstances and succeeded was essential to raise hopes and ambitions of the mentees. The literature has shown that same-gender mentoring for women is more successful (Leck et al., 2012). Packard mentioned that mentors who share characteristics with their mentees can be seen by their mentees as "possible selves" (Packard et al., 2004). In Chapter 4, the mentees were amazed by the achievements of their mentors and were also relieved that such fields and careers were available to Saudi women. One mentor mentioned the importance of presenting Saudis as mentors and increasing their visibility because, from her experience, she found that young Saudis had a conception that accomplishments and successes in STEM cannot be achieved in Saudi Arabia or by Saudis. All the mentors who participated in this research (Chapter 4 and Chapter 7) understood the struggles the mentees faced. Mentors explained their previous experiences when they were young and how they needed support and guidance. Mentees in Chapter 7 insisted on the importance of having a female Saudi mentor. They thought that they would feel more comfortable talking to a female and they wanted someone who lived in the same culture and circumstances. They believed that if the mentor had not been in the same circumstances, then they would not benefit from the relationship. One mentor experienced discomfort from her mentee when some member of her family entered the room while they were talking. The mentor reported that the mentee might get into trouble if she was talking to a male mentor.

Another aspect is that one main goal of this research was to create visibility for professional Saudi women in STEM. For women in Saudi Arabia and similar contexts, well-designed and well-utilised e-mentoring has the potential to promote the social capital of both girls and female professionals. Lack of professional support for women in Saudi Arabia is recognised as a major barrier to the professional development of women and contributes to the underrepresentation of women in the workforce (Al-Ahmadi, 2011; Alomair, 2015). During the recruitment of mentors for this research, I faced difficulties in finding female Saudi STEM professionals, not because of a lack of such professionals, but because of the

lack of communities and networks of female Saudi professionals. Existing platforms such as LinkedIn helped me find professional women, but I still faced the problem of their lack of visibility. Mentors in Chapter 7 expressed their intention to contact other mentors through *Qudwa*, which may lead to professional mentoring relationships. Previous literature has stressed the need to understand the development of professional support networks and interventions for women in Saudi Arabia such as mentoring and networking (Alsubaie and Jones, 2017). Indeed, given the lack of female professional networks in Saudi Arabia, participation in appropriately configured e-mentoring could be a pillar on which such networks might be constructed.

Due to the lack of documented work on e-mentoring in Saudi Arabia, the first research question was to explore the potential for applying e-mentoring in Saudi Arabia. This research showed evidence of the potential e-mentoring has in Saudi Arabia for advocating STEM and showed the need for e-mentoring in other fields as well. It discussed the problem of lacking reliable Arabic online resources, which may be one additional factor in the need for e-mentoring in Saudi Arabia. While examining the potential for e-mentoring, the cultural norms of the Saudi context were not as important as expected, but the fact that the mentors were female and Saudi was important to increase their visibility and promote the social capital of both girls and female professionals.

8.3   The E-mentoring Design

In this section, I revisit the following two research questions. This section reflects on the factors that contributed to the design of a STEM e-mentoring system and how the design was created. It discusses the changes in the form and design requirements of e-mentoring that resulted from this research. It also reports on the enhancement that the central website (*Qudwa*) had over existing social media technologies. Furthermore, it discusses how the e-mentoring design can be evaluated and how the absence of mentors' input in the design process affected their e-mentoring experience.

8.3.1   *Redesigning e-mentoring*

This exploratory research started with expectations and assumptions that have proven to be of less importance. In the beginning, the cultural factors of Saudi Arabia were the main driver for the design of the pilot study (Study 1 in Chapter 4). As mentioned earlier, in Chapter 4 the privacy requirements of the female participants in the Saudi context, the selection of the mode of communication and parental involvement were the cultural factors that were thought of as requirements in designing e-mentoring for females in Saudi Arabia. The findings of Study 1

showed that these factors were not as important as expected. The participants preferred other means of communications and none of the parents participated in the study. In fact, the interviews and focus group that were conducted at the end of Study 1 presented different requirements than expected. This highlighted that the mentees desired a different style of e-mentoring that had more to do with their generation than Saudi culture. Co-design studies in Chapter 5 with the target group emphasised that the cultural norms of the Saudi context were less important in the design than the generation traits of the participants. The participants in Chapter 5 did not show concern about the cultural factors used in Study 1 or any other cultural factors. The format of e-mentoring that the participants desired is possibly linked to the communication preferences and online practices of their generation. This finding has shifted the design of e-mentoring from culture-specific to generation-specific.

Rowland (2012) in her work discussed the effect of generational differences on e-mentoring. She addressed the generational differences between mentors and mentees from a technology-use perspective. She argued that older generations (Generation X, born 1966–1976) might not accommodate e-mentoring because they think online communications are impersonal and they are not considered to be technology savvy in comparison to Generations Y (born 1977–1994) and Z (born after 1994). Generations Y and Z are considered to have more knowledge about technology and to use it more than the previous generation. It is possible that challenges might occur when mentors from Generation X mentor mentees from Generations Y and Z (Rowland, 2012). In this research, generational differences existed but not in the technology use but in the design and structure of e-mentoring. The findings of Chapter 7 showed that the mentees were happy with the nature of the relationship; on the other hand, the mentors showed different views. The mentors wanted stronger and longer relationships with their mentees. They believed that they put their emotions and feelings into the relationships and wanted them to grow and last. This finding presents another generational difference between the mentees and the mentors.

Previous e-mentoring frameworks and models (Bierema and Merriam, 2002; Single and Muller, 2001) were built earlier in time for an older generation and utilising technologies that are less developed than current technologies. They attributed the success of the e-mentoring relationship to frequent, continuous contact between mentors and mentees. In Chapter 5, the design requirements extracted from the co-design workshops did not show any relation to regular, frequent meetings with mentors; in contrast, they expressed less committed relationships. In this research, a new form of e-mentoring has emerged that is different to the known structured form of e-mentoring. Possible explanations for this change might be the change in generations and the advancement of technology. These explanations are consistent

with what Williams et al. (2012) reported. They discussed that it is hard to construct a fully developed e-mentoring model due to the rapid advancement of technology. They suggested that practitioners and researchers in the future should be flexible in designing e-mentoring based on the development of all aspects involved in the process. Further studies on the topic of e-mentoring with other populations and different contexts are recommended. Co-design methods in this research have helped in understanding the reason behind the low participation of the mentees (in Chapter 4). They also helped in changing the form and requirements of e-mentoring from a structured e-mentoring form to a less structured form and from a design based on culture to a design based on age group traits.

While the design requirements were derived from the age group traits, it is possible that the context of Saudi Arabia had some effect on which of the traits were dominant. While the culture did not affect the technology design, its effects were more prominent in the lack of Arabic content, the lack of awareness of female Saudi professionals in STEM and the lack of professional networks for females in Saudi Arabia. As discussed earlier, professional women in Saudi Arabia have low visibility and lack professional female networks. This factor may have contributed to the need for the mentees to be connected with as many mentors as they wanted. It is possible that when conducting co-designing methods with the same age group and with the same purpose of advocating STEM but in different regions that have more visibility of professional females, other generation traits might appear and dominate the design requirements. I argue that e-mentoring is not a one-size-fits-all process and that further investigations of the inclusion of co-design methods in other settings of e-mentoring are recommended. The insights from the co-designing sessions (Chapter 5) have changed my perspective and enlightened me about the participants and e-mentoring in Saudi Arabia. My expectations about e-mentoring have been influenced by my experience of being a Saudi STEM professional who lived, studied and worked in Saudi Arabia. While I assumed that I have a good understanding of the culture, my assumptions and expectations have proven to be less important than other factors. The user-centred design approach adopted in this research gave me a new perspective about my culture and how Saudis interact with new experiences and technologies.

8.3.2 *Supporting social media technologies*

The increasing use of social media around the world and in Saudi Arabia specifically has brought people closer and eased communication. Logically, this means that youth should easily be able to find professionals to help and guide them. The findings presented in this research showed the contrary. In Chapter 7, the mentees expressed their struggle in finding

someone who would professionally answer their questions or guide them. They tried to reach out to professionals (on different social media platforms) who they thought they would be able to help them, but they were either ignored or only briefly answered by the professionals. While *Qudwa* was built on the concept of unplatforming, which means taking advantage of and utilising existing technologies, the findings showed that the sole existence of these technologies was not enough to provide what the individuals needed. The mentees reported that what made *Qudwa* special was not only the communication methods, but that they were confident they would find the answers they needed.

Qudwa was a central website that acted as a meeting point for mentors and mentees. It created a space for mentors who were willing to volunteer to help and guide, and created a trusted space for mentees to find those mentors through technologies they were already using. In the recruitment process for Study 1 and Study 4, I faced problems in finding those mentors due to the lack of professional networks for women in Saudi Arabia. I relied mainly on LinkedIn and my personal contacts. Even as a professional, many of my contact attempts on LinkedIn were ignored. The mentors who agreed to participate showed enthusiasm to help and participate. They valued the opportunity given to them. They had previously provided help and guidance to young people, but their help was limited to their surroundings and people they knew. They also showed their support to people who reached them through social media platforms. The chance for young women who are seeking advice or guidance to know which of the randomly available professionals on social media platforms are willing to help is very low. Therefore, *Qudwa* as a central website had a major role in providing a pool of professionals who were willing to mentor and to give the opportunity to those professionals to widen their help to a wider group of teenagers and young women. Other studies reported that mentees described having their mentors in one place as "directly accessible" (Savoy, 2013).

Lambton-Howard et al. (2020) referred to the use of external technologies (e.g. central websites) beyond the boundaries of the employed social media technologies as "hard augmentation". Hard augmentation is used to overcome the limitations of social media technologies. Lambton-Howard et al. (2020) described two case studies where hard augmentation was applied. In WhatFutures (Lambton-Howard et al., 2019), an external website was set up to overcome the limitation of WhatsApp groups not being able to view each other's activity. The administrators of WhatFutures uploaded the activity of each WhatsApp group on the leader board of the website to increase motivation and engagement between groups. In Online UWC (Celina et al., 2018, 2016), which used Facebook, Google Hangouts and Google+ for messaging and communication, a central website was designed to facilitate scheduling between participants. Similarly, in *Qudwa* the hard augmentation or the

use of a central website enabled finding mentors who were willing to help, created visibility of female STEM professionals and was used for scheduling. *Qudwa* further supports the idea proposed in Lambton-Howard et al. (2020) that future research should explore how hard augmentation can be used as an enhancement and improvement that supports existing social media technologies.

8.3.3   *Effectiveness of e-mentoring*

One of the goals of this research was to raise awareness of existing female Saudi professionals in STEM and guide the mentees in their choice of STEM field. The pilot study in Chapter 4, although it was on a small scale and had low interaction levels, showed positive outcomes for both the mentors and the mentees. Chapter 4 reported that low participation numbers did not translate to lesser effectiveness or impact. The quantitative data for interaction frequency and duration did not meet the expectations. The chapter also reported that high levels of participation do not inevitably mean that there is interaction between the mentors and the mentees, as some mentors were writing several posts without receiving any feedback or interaction from their mentees. On the other hand, mentees and mentors showed some level of impact. The mentees reported that their level of awareness of female Saudi professional in STEM had risen and some mentees reported that they did not know that such careers existed for women in Saudi Arabia. Both mentors and mentees shared their positive experiences with the people around them. One mentee reported that her e-mentoring experience and connection with the mentor had increased her love of science. Another expressed that her participation made her more reassured about her choice and gave her more options about her future.

Chapter 7 showed the same results of a higher level of awareness, positive feedback and actions taken by the mentees after their participation. Even though mentors felt the vagueness of their impact, the interviews with mentees showed a different level of impact. For example, one mentee changed her study major after being in contact with two mentors. Other mentees mentioned that they were seeking certain information and their participation resulted in increasing their knowledge about it. Peer influence was highly noted; mentees shared their experience with their peers and also recommended *Qudwa* to them. The impact reached visitors to *Qudwa* as well. One visitor reported that she did not submit a contact request, but browsed the mentors and was surprised by their majors and qualifications. The mentors had their share of positive impact. Some mentors showed their pride in the range of mentors in different fields. They also browsed the social media accounts of those mentors. Other mentors

expressed the personal benefits *Qudwa* provided for them. Their participation as mentors satisfied their need to give and added more value to their lives.

Previous research reported that the number of sessions between a mentor and a mentee is important for effective e-mentoring (Bierema and Merriam, 2002; Single and Muller, 2001). Some programs faced problems in maintaining e-mentoring relationships and suffered from low interaction, but these studies showed positive outcomes and appreciation from the mentees (Lee and Noh, 2003; Savoy, 2013; Stoeger et al., 2013). The aim of this research was to establish further understanding of e-mentoring in Saudi Arabia due to the lack of previous work on e-mentoring in the context, so this research did not aim to measure the effectiveness of e-mentoring specifically. Although the numbers of visits to websites, interactions and sessions held can be tangible measurements of the effectiveness of e-mentoring, other different forms of intangible impact are also worth considering to measure the effectiveness of e-mentoring including peer sharing, recommendations and personal and professional impacts on mentors.

8.3.4 *Mentors' perspective*

This study has been limited by the inclusion of mentees only in the design process and therefore eliciting the design requirements from the mentees' side. Although mentors' experiences with e-mentoring in Chapter 4 (the pilot study) and Chapter 7 (*Qudwa*) were taken into consideration and used for evaluation purposes, mentors were not included in the design process. In Chapter 4, the mentors acknowledged the low interaction between them and the mentees, yet some mentors tried to establish a personal connection and others tried to engage them through activities. In Chapter 5, the participants recognised the mentors' efforts and appreciated their valuable time. Several suggestions were made in the co-design workshops that addressed the mentors. Some suggested giving feedback or evaluations, others gave control to mentors in the case of mentees missing their scheduled sessions and some shared the accomplishments a mentee had made with the help of her mentor. The findings in Chapter 7 (*Qudwa*) showed that the mentors desired a more connected relationship, as opposed to the less committed relationship wanted by the mentees. They also provided valuable input on how to improve *Qudwa* and reduce pressure and repetition for the mentors. The findings of *Qudwa* showed that mentors gained personal benefits from their participation as mentors. It satisfied their needs to give and help, made them feel better about themselves and created a positive change in their lives. Although mentoring in general is considered a mutually beneficial relationship, previous literature has focused more on the outcomes for the mentees and less on the outcomes for the mentors (Beltman and Schaeben, 2012; Williams et

al., 2012). Consistent with the literature, this research suggests that more effort is needed to address and enhance the outcomes of e-mentoring for mentors. Therefore, there is a need to include mentors as key stakeholders in co-design workshops for e-mentoring to develop a design that satisfies both parties.

Two research questions of this research were to identify the factors that would contribute to an e-mentoring design and the creation of a design based on these identified factors. The co-design methods helped in understanding the requirements of the mentees, who were from a different generation. The redesign of e-mentoring based on the identified factors resulted in *Qudwa*. The un-platforming design of *Qudwa* shows the potential of existing technologies and social media platforms to facilitate a new form of e-mentoring. This research shows how to evaluate e-mentoring from different perspectives. It also shows the importance of mentors' input in the evaluation and design processes.

8.4 Design Implications

Channel and medium of communication: Textual communications were used in Chapter 4 and Chapter 7 but on different platforms; in Chapter 4 Edmodo was used and in Chapter 7 the textual method was WhatsApp, a channel that mentors and mentees were already using. The findings of Chapter 4 reported that the communication method (i.e. text-only) was a barrier, as participants said that they wanted a method that would help them to easily express themselves, such as audio and video, while in Chapter 7 that same textual communication method was favoured and highly requested. As both methods are textual in nature, this implies that, while having flexibility in the type of media used for communication is important (see below), the findings from Chapter 7 show that the communication channels (i.e. the tools used), and their familiarity and level of use, are even more important than the nature of the communication media.

Flexibility: Another design implication related to communication channels is providing flexible e-mentoring relationships (one-to-one e-mentoring vs. group e-mentoring, textual vs. audio and on-when-needed vs. scheduled) to accommodate mentees' different personalities and preferences. In Chapter 4 only one method of communication was available and the mentees were grouped together, which might have increased the sense of the communication method as a barrier to their relationships. In Chapter 7, some mentees joined the WhatsApp group of a mentor and requested a one-to-one audio call with the same mentor. They reported that the audio calls were needed to discuss personal matters that they preferred not to share with others, while the WhatsApp groups were for more general matters and to gain benefits

from the discussions with others. It is not clear which factor was more important to them, the method of communication being audio or that they preferred a one-to-one session. Although it was not an available option, the findings did not show any mentee who requested a one-to-one conversation with a mentor through WhatsApp or mentees who contacted their mentors privately through WhatsApp. The findings showed mentees with different personalities and preferences. The findings also presented how some mentees changed their requests several times; some changed the medium of communication and others who sent multiple requests to contact more than one mentor cancelled some of their requests. Some mentees preferred WhatsApp and others preferred audio calls. Some mentees were shy and lacked confidence, or just did not know what to expect. One mentee said that she thought she "is not good with people" and she was hesitant to have an audio call, but she felt more confident by the end of the audio call. Therefore, providing such flexibility is an important design recommendation to help mentees initiate e-mentoring relationships that fit their needs.

Raising awareness: Another design implication is to create more visibility of female STEM professionals and raise awareness of career options by highlighting mentors' qualifications and work experience. The findings of Chapter 4 and Chapter 7 showed that the mentees did not expect females to work in such fields or careers. In Chapter 4, mentees and mentors shared their experiences with e-mentoring and their knowledge about female Saudi STEM professionals with people around them. In Chapter 7, some mentors visited other mentors' pages and showed an intention to be in contact if their career paths crossed. This visibility was not limited to the mentees and mentors, but also reached the visitors to *Qudwa*. In Chapter 7, one submitter (who only submitted a form but did not get in contact with any of the mentors) reported that she was amazed by the qualifications and achievements of the mentors. By publicising the group of participating mentors, their qualifications and experiences, the mentees were exposed to the variety of STEM career options available to them.

Use of mainstream communication tools augmented with a central website: This research provides evidence that to support e-mentoring, it is not required or even desirable to develop a standalone or bespoke system. Utilising existing technologies and social media platforms is a key factor in the success of such systems, as demonstrated by the co-design workshops, deployment and evaluation of *Qudwa*. Utilising social media platforms that were embedded in the daily internet activity of the mentors and mentees eased the process of e-mentoring. A significant factor was that e-mentoring was initiated in a space that mentors and mentees already occupied. These existing platforms were augmented by a central website to achieve

the goals of this research. The idea of un-platforming is supported by the work of Lambton-Howard et al. (2020). The findings of the two separate research projects in Open Lab, despite their different aims, led to the same conclusion of augmenting existing social media platforms with a central website.

Adopting a co-design approach: Co-design workshops with the target group had a significant effect on the design. In Chapter 5, the co-design methods used were chosen to give the participants power and agency to design their own e-mentoring experience. The findings reported the importance of including the mentors as well, as they are considered a key factor in the success of e-mentoring. E-mentoring is a mutually beneficial relationship between a mentor and a mentee; therefore, it is important to address the needs and requirements of both parties to balance the design for a more effective e-mentoring relationship. This research suggests the inclusion of all stakeholders in an e-mentoring relationship in the design process by using appropriate co-design methods for each party.

Recruitment: The diffusion of social media in everyday life, especially with the youth population, presents opportunities for influencing, recruiting and targeting such populations. In this research, Facebook was eliminated as an option for recruitment due to its low use in Saudi Arabia and Twitter was thought of as an appropriate platform for promoting an educational/career-related topic. In Chapter 7, due to the low recruitment numbers from Twitter at the beginning of Study 4, Instagram was used as an additional method for recruitment. The insights from the ads showed that Instagram had more impressions, clicks and interactions than Twitter. The number of visits to *Qudwa* from Instagram was 1,554 in comparison to 82 clicks from Twitter. The post-study survey showed that 44% of the mentees thought that Twitter would be a suitable platform for promoting *Qudwa* and only 17% thought that Instagram was a suitable platform for promotion. The insights provided by the social media contradict the results of the survey. The insights showed more interaction from Instagram than from Twitter. These contradictions may be a result of the mentees perceiving Twitter as a more appropriate platform for a service like *Qudwa*, but the online availability of youth on other social media platforms such as Instagram made *Qudwa* more visible and accessible to them. The mentees reported that 43% of them knew about *Qudwa* from Twitter and 38% from Instagram; while there is no significant difference between these numbers, the Instagram ad insights showed higher numbers of visits and interactions, which may have contributed to raising the awareness of the visitors about female Saudi professionals in STEM just by visiting *Qudwa* (as discussed earlier). It is recommended to use social media platforms for youth research recruitment and examine which platforms are more appealing and would

result in more recruitment.

8.5   Limitations and Future Work

As mentioned earlier, an issue that was not addressed in this research was the measurement of effectiveness in e-mentoring. This research has presented intangible positive effects of e-mentoring on both mentors and mentees that are worth considering in future research when measuring the effectiveness of an e-mentoring design. Another limitation was that mentors were not included in the design process. The inclusion of mentors in the design process would help in designing e-mentoring that is balanced between the needs of the mentors and the needs of the mentees.

It was noted from Chapter 4 and Chapter 7 that there was a misunderstanding on the mentees' side about what mentoring means, due to the absence of the concept of mentoring in Saudi culture. Although the research purposes and concepts were described for the mentees in Chapter 4 and an additional animated video was used in Chapter 7 to promote *Qudwa*, the findings showed that some mentees had different expectations. For example, some mentees thought that *Qudwa* would provide courses or explicit answers on what major to study or suit them. This research acknowledges the absence of mentoring in Saudi Arabia, yet introducing the concept of mentoring to the participants was not addressed. Future research should look into how to introduce a new concept to such a culture to increase its effectiveness and use.

In Chapter 5, two different groups from different socio-economic backgrounds were included in the design process, and both groups showed similar requirements for an e-mentoring design, yet this research is considered of a small scale and did not cover the different backgrounds of the Saudi society. Conducting larger-scale research would result in gaining more understanding about the requirements and design of an e-mentoring system in the context of Saudi Arabia.

In Chapter 7, I faced the problem of mentees who did not answer the survey, ignored my interview requests or suddenly stopped responding to interview questions. This limitation lessened my understanding of the mentees' experience with *Qudwa*. Future work should look into how to engage mentees in the evaluation process considering their age group. Furthermore, *Qudwa* presented mentees with different personalities, different understanding of e-mentoring and different interactions with their mentors, conducting larger-scale research would result in developing a better understanding of how different participants with different backgrounds and personalities would interact in *Qudwa*.

Additional future design work on *Qudwa* was discussed in Chapter 7. This future work included the automation of some processes on *Qudwa*, such as scheduling, handling of

contact requests by the mentors and collaboration between mentors to provide answers to commonly asked questions. These to-be-automated design recommendations do not imply the elimination of the human presence, which was a design requirement that was favoured by the mentees in creating a trusted connection between mentors and mentees. The *Qudwa* feature *Introduction through social media* did not work as expected due to privacy controls on the social media platforms. In future work, I would test the need for this feature from the mentees' perspective and try to overcome the barriers faced. Mentees made several suggestions of other social media platforms such as Snapchat and Telegram, which suggests examining the appropriateness of using these platforms on *Qudwa*, especially to conduct audio calls, as some mentees thought that the used platform (appear.in) was not a platform that they commonly used.

8.6   Conclusion

This research has presented investigations that addressed young women, the Saudi context and the design requirements of e-mentoring in such a context through a number of engagements with Saudi women (mentees and mentors). This work succeeded in addressing the three research questions. Four studies were conducted to address the research questions. The first study showed the applicability and need for e-mentoring in Saudi Arabia which was the concern of the first research question. The second and third studies addressed the second research question. They helped in gaining insights and collecting requirements to design an e-mentoring system. The final research question was fulfilled through the design and deployment of *Qudwa*. This research has concluded with several recommendations for future research and, despite its small scale, has demonstrated the need for mentoring and e-mentoring in STEM and other fields, and resulted in a successful deployment in the Saudi context, the last phase of which was the *Qudwa* e-mentoring system, which was developed based on the design requirements identified through earlier studies.

This research has also brought into focus the problem of the lack of reliable Arabic online resources, which may have contributed further to the need for mentors. It highlights the importance of having female Saudi mentors to mentor female Saudi teenagers and young women, because they are similar in the sense of living in the same culture and facing the same challenges. One of the most significant findings of this research is the role that the co-design workshops played in redesigning e-mentoring based on the traits of the generation, rather than the cultural factors. This research has identified the need for co-design as a method to support the design of e-mentoring in Saudi Arabia and particularly for this generation of future women professionals. The two co-design studies concluded with factors and design

recommendations to implement and evaluate a design concept driven by these co-design studies. The suggestion to include mentors in the design process has been presented to develop a design more suited to both mentors and mentees.

Following the research questions, three contributions are recognised. First, this is the first documented systematic investigation of e-mentoring in Saudi Arabia. The lack of previous examples applied in the same context pointed to the need to understand the cultural norms that would affect the application of e-mentoring in Saudi Arabia. While I aimed to understand the role of cultural norms, the studies demonstrated that the findings were affected less by cultural norms and more by the traits of the participants' generation. This research proves the applicability and success of e-mentoring in Saudi Arabia for teenagers and young women, and suggests the application of e-mentoring in other fields and settings in Saudi Arabia and the Arab region.

Second, the application of co-design methods helped in addressing the gap in understanding the needs and opportunities for designing e-mentoring. This research presents new insights into how co-design methods are beneficial in designing e-mentoring for young people. The results point to the need for a redesign of e-mentoring models for younger generations with less committed and more flexible relationships. Other forms of e-mentoring could emerge from applying co-design methods with different purposes and different populations.

The final contribution is the design, deployment and evaluation of a new form of e-mentoring. *Qudwa* is an e-mentoring design that is based on facilitating e-mentoring through existing social media technologies and practices (un-platforming). This contribution shows the potential of existing technologies and social media platforms to facilitate a new form of e-mentoring. This research directs future research to further investigate e-mentoring in the context of Saudi Arabia and similar contexts, to further explore the possibilities of other designs of e-mentoring in other contexts by applying co-design methods and to examine different applications of un-platforming.

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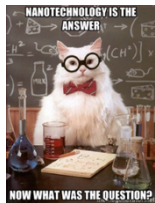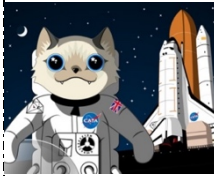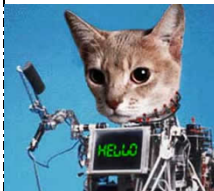
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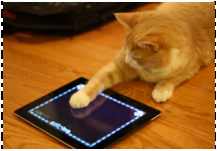
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Appendix A Pilot Study

A.1 Mentors Profiles

Group A Mechanical Engineering, (Nanotechnology) & Physics King Abdulaziz City for Science and Technology *About me:* By applying my results of research and studies to reality, definitely help in advancing technologies in innovative fields such as Nanotechnology, Electronics, Photonics, Space and Aeronautics, and Medicine. As a Saudi woman, I seek to become a regional leader in my critical and specialized areas. My mission of dedicating the time intensively toward conducting national research aims to contribute to the development of the Kingdom of Saudi Arabia.	
Group B Science Communication NASA Ames Research Center *About me:* I love science and talking about science. I currently work at NASA Ames Research Center in Mountain View, California. Specifically, I work at NASA's Solar System Exploration Research Virtual Institute (SSERVI). My work is in the field of citizen science projects which mainly focus on public participation in the process of scientific research. Furthermore, part of my job focuses on international collaborations in solar system research. My interests also lie in understanding the impact of science and technology policy decisions on society.	
Group C Science and Technology - Machine Learning, Computer Vision College of Computing- Georgia Institute of Technology *About me*: My research areas are Computer Vision and Machine Learning; in my research we help computers understand images as we do. We teach computers to analyze any scene and ask them to describe the scene, as a human would do. Soon, computers will tell us if an image is funny or not! It well also tells us a picture make the computer happy, sad, or confused! This will help the robotics to move in our world safely and freely. And will make the interaction between human and robotics more natural.	
Group D Microbiology King Abdulaziz University *About me:* Obtained PhD in Microbiology/Virology from King Saud University, Riyadh, Saudi Arabia in 2006. Joined King Abdulaziz University (KAU), Faculty of Medicine as an Assistant Professor of Microbiology. Actively participates in international meetings relating to research and education and she was an invited speaker in several conferences and symposiums.	

Group E Interactive media design Princess Norah University *About me:* Hi, my name is *****. I work as Lecturer in Princess Norah University. in Graphic design and digital media department. During our journey together we will explore and create magical interactive project in fun and easy way.	
Group F Engineering / Architecture Dar Al Hekma University *About me:* A young architect who appreciates innovative experiments and aims to fill the gap between the academic field and professional practice.	
Group G Game Development Semanoor & ALFAC *About me:* I design games, characters, battles and write the code to see them come to life.	
Group H Computer Science – Space Technology KACST - National Satellite Technology Center *About me:* I am working in Imaging Payload for satellites. I started with CAD Designer - systems engineer then as PM for the project. Working in engineering areas is really interesting and exciting, the way of solving the problem, the way you can see your designs in real life, the way you learn each day something new are all joyful and interesting. Knowing that you are working in a unique field, in a space related tasks, and facing challenges that are not common in the world are really challenge and way to prove that ladies are always capable to work and contribute significantly.	

A.2 Pre-Study Survey for the Mentees

This survey is intended to collect data about you and your daughter as part of your participation in the e-mentoring program.
Please compete the following about you and your daughter who is participating in the study.
The first section to be completed by the you, the second section is to be completed the mentee (your daughter) with your help.

First section:
This section to be completed by the parent/guardian/carer.

Mentee's Name:

Date of birth:

Grade at school:

1) The child lives with her:
   a) Mother
   b) Father
   c) Both parents
   d) Other (Please state relationship to child) …………….

2) How old is the father?
   a. 25-30
   b. 30-45
   c. 45-60
   d. 61 or older

3) How old is the mother?
   a. 25-30
   b. 30-45
   c. 45-60
   d. 61 or older

4) If the child is living with someone other than her parents, how old is he/she:
   a. 25-30
   b. 30-45
   c. 45-60
   d. 61 or older

5) Which province do you live in:
   a. Central province
   b. Eastern province
   c. Western Province
   d. Northern Province

     e. Southern Province

City: …………………..

6) What is the highest level of education the father has completed?
    a. High school degree
    b. Bachelor's degree
    c. Master's degree
    d. Doctoral degree
    e. Professional degree (MD)
    f. Other ………………………………..

7) What is the highest level of education the mother has completed?
    a. High school degree
    b. Bachelor's degree
    c. Master's degree
    d. Doctoral degree
    e. Professional degree (MD)
    f. Other ………………………………..

8) If the child is living with someone other than her parents, what is the highest level of education he/she has completed?
    a. High school degree
    b. Bachelor's degree
    c. Master's degree
    d. Doctoral degree
    e. Professional degree (MD)
    f. Other ………………………………..

9) What is the major of the father?
    a. Science
    b. Engineering
    c. Technology
    d. Medicine
    e. Business
    f. Other, specify …………

10) What is the occupation of the father? Where does he work?

11) What is the major of the mother?
    a. Science
    b. Engineering
    c. Technology
    d. Medicine
    e. Business
    f. Other, specify …………

12) What is the occupation of the mother? Where does she work?

13) If the child is living with someone other than her parents, what is the major of him/her?
    a. Science
    b. Engineering
    c. Technology
    d. Medicine
    e. Business
    f. Other, specify …………

14) If the child is living with someone other than her parents, what is his/her occupation? Where does he/she work?

15) Has anyone in the family been in a mentoring program? Who?

16) How did you know about this program?
    i. School
    ii. Event
    iii. Friends
    iv. Social network, specify ……………..
    v. Other, specify …………………….

Second section:
This section is to be completed the mentee (your daughter) with your help.

1) Do you know any adult who works in science, engineering or technology careers? Yes | No | Not sure
2) Do you know any woman who works in science, engineering or technology careers? Yes | No | Not sure
3) Are you excited to be in the mentoring program? Yes | No | Not sure
4) Do you think that you will benefit from the mentoring program? Yes | No | Not sure
5) Did anyone influence you into joining the e-mentoring program? Yes | No | Not sure
If yes, who? ……………………..
6) Why did you join the e-mentoring program?
7) Have you ever been in a mentoring/e-mentoring Program? Yes | No | Not sure
8) Has anyone in the family been in a mentoring program? Who?
9) How did you know about this program?
    i. School
    ii. Event
    iii. Friends
    iv. Social network, specify ……………..
    v. Other, specify …………………….

A.3 Post-Study Survey for the Mentees

Dear Mentee,

This survey is intended to collect data about your experience with the e-mentoring program. It is composed of two parts. The first part contains open ended questions please feel free to elaborate your answers. The second part has statements that we would like to know your view about them regarding the e-mentoring experience.

Part 1: Please answer the following questions regarding your experience with the e-mentoring program. Feel free to elaborate:

- Would you describe your e-mentoring experience as a positive one?
- Did you find the 8-week program an appropriate duration?
- If no, would you prefer the program to be shorter or longer? What duration would you see as ideal?
- How would you describe your relationship with your mentor? Please elaborate
- Please describe an example of a recommendation/idea/advice that your mentor suggested, and you benefited from it.
- What do you think is the best thing about e-mentoring?
- What do you think is the biggest problem with e-mentoring?
- Which means of communication would you like to use on the e-mentoring program, select all that apply:
    a) Audio calls
    b) Video calls
    c) Video snaps and clips
    d) Synchronous communication such as chat
    e) Asynchronous communication such as discussion boards and forums.
    f) Other, ………………………….
- Describe the benefits of the program to you
- What would you suggest to improve the program?

Part 2: Indicate your view of the following aspects of your e-mentoring experience.
 (For each of the items please indicate your agreement or disagreement with the following statements. Please tick √ your response.)

	Strongly agree	agree	Neither Agree nor Disagree	disagree	Strongly disagree
1) My mentor is always interested in what I want to talk about.					
2) My mentor thinks of fun and interesting things to talk about.					
3) I feel bored when I participate in the e-mentoring program.					
4) I enjoyed participating in the e-mentoring program.					
5) I benefited from participating in the e-mentoring program					
6) After the e-mentoring program, my awareness of STEM careers has increased.					
7) After the e-mentoring program, my confidence in myself has increased.					
8) I spent most of time on my group reading posts					
9) I spent most of time on my group writing posts					
10) The e-mentoring program consumed a lot of my time.					
11) I was confident enough to write and express my opinions to my mentor.					
12) Being in a group with mentees is distracting.					
13) Being in a group with mentees showed me their different perspectives.					
14) In the future, I will participate in a mentoring program.					
15) Using online communications make it hard for me to understand my mentor.					
16) I want to meet my mentor physically.					
17) I am satisfied with the advice, assistance and support provided by my mentor					
18) I am satisfied with the frequency of contact with my Mentor					

A.4   Semi-structured Interview Questions for the Mentors

1. Did you ever have a mentor, and do you have any mentors in your life right now?
2. If yes, what impact did being mentored affect your life?
3. Why do you want to be a mentor?
4. What expectations did you have about the e-mentorship program?
5. Did you have any doubts or concerns about being a mentor?
6. Would you describe your e-mentoring experience as a positive one?
7. In your opinion what are the strengths of the program?
8. What aspects of the program would you like to improve?
9. How would you describe your relationship with your mentees? Please elaborate
10. Did you feel overwhelmed or burdened by participating in the e-mentoring program?
11. Please describe an example of a recommendation/idea/advice that you suggested to your mentee and you feel that she benefited from it.
12. Would you volunteer to serve as a mentor again in the future? Why or why not?
13. Which means of communication would you like to use on the e-mentoring program?
14. What would you suggest to improve the program?

A.5 Semi-structured Interview Questions for the Mentees

1. Did you ever have a mentor, and do you have any mentors in your life right now?
2. Would you describe your e-mentoring experience as a positive one?
3. In your opinion what are the strengths of the program?
4. What expectations did you have about the e-mentoring system?
5. Why did you join the program?
6. Why did you choose your mentor?
7. What barriers or problems did you face during your participation?
8. Did you share your experience or what you have learned with others?
9. Would you join an e-mentoring program again?
10. Which means of communication would you like to use on the e-mentoring program?
11. What would you suggest to improve the program?

A.6   Semi-structured Interview Questions for the Parents

1. What is your highest level of education? Your major?
2. Have you ever been mentored? by whom?
3. What do you think mentoring is?
4. If your daughter asked you to join an e-mentoring program that uses video communications, would you agree? Why or why not?
5. What are your concerns regarding e-mentoring?
6. How do you think these concerns would be eliminated?
7. What do you think the benefit of mentoring is to your daughter?

Appendix B Co-design Workshops

B.1   Survey

Dear Participant:

This survey is intended to collect data about you as part of your participation in the design session of an e-mentoring platform.

1) How old are you?

2) How old is your father?
   a. 30-45
   b. 45-60
   c. 61 or older

3) How old is your mother?
   a. 30-45
   b. 45-60
   c. 61 or older

4) What is the highest level of education your father has completed?
   a. Illiterate/ not educated
   b. High school degree
   c. Bachelor's degree
   d. Master's degree
   e. Doctoral degree
   f. Professional degree (MD)
   g. Other ………………………………..

5) What is the highest level of education your mother has completed?
   a. Illiterate/ not educated
   b. High school degree
   c. Bachelor's degree
   d. Master's degree
   e. Doctoral degree
   f. Professional degree (MD)
   g. Other ………………………………..

6) What is the major of your father?
   a. Science
   b. Engineering
   c. Technology
   d. Medicine
   e. Business
   f. Other, specify …………

7) What is the occupation of your father? Where does he work?

8) What is the major of your mother?
   a. Science
   b. Engineering
   c. Technology
   d. Medicine
   e. Business
   f. Other, specify …………

9) What is the occupation of your mother? Where does she work?

10) Number of family members (father, mother and siblings)

11) Did all you siblings who are older than 17 have been enrolled in higher education?
   a. Yes
   b. No

12) Do you have a female role model in your life?
   a. Yes
   b. No
   c. I don't know

13) If you answered Q.13 with yes, do you communicate with her?
   a. Yes
   b. No

14) Do you feel sometimes the need to talk to someone regarding your study or future career?
   a. Yes
   b. No
   c. Maybe

15) Do you have a clear vision and knowledge about career options available for your field of studying?

Appendix C *Qudwa*

C.1   System Architecture

The system of *Qudwa* consists of three main components: front-end, backend, and database. The front-end which is a static website is built using Jekyll (https://jekyllrb.com/) and hosted on GitHub pages. Jekyll was chosen because it reduces the complexity and need for deploying a dynamic content management system (CMS) by generating a static website from markdown files with GitHub repositories. The front end connects to the application programming interface (API) using JavaScript to send form submissions and analytics data. The backend is built with NodeJS as an Express server (https://expressjs.com/) and hosted on Open Lab servers. The backend helps in two parts. For the first part, it exposes a number of API endpoints that can be used to collect analytics data and form submissions from the website, storing them in *Qudwa*'s database and displaying them on the admin panel. The second part offers an interface for the admin to edit the content of *Qudwa* without directly interacting with the GitHub repository. It achieves that by utilizing GitHub API to create a new commit to *Qudwa*'s repository every time the content is edited, which triggers GitHub to rebuild the front-end and serve the updated *Qudwa* website. The third component of *Qudwa* is a MySQL database, which is hosted on Open Lab servers. It is used to store analytics data and form submissions.

C.2   Post-Study Survey

Dear Mentee,

This survey is intended to collect data about your experience with Qudwa. It is composed of three parts: the nature of the relationship, communication channels and the impact of *Qudwa* on you.

Nature of Relationship

1. Have you ever talked to a professional to help you find answers regarding your studies or career?

   - Yes
   - No
     If yes, please explain ………….

2. How would you rate your overall experience with *Qudwa*?
   - Very good
   - Good
   - Somewhat good

- Neutral
- Somewhat bad
- Bad
- Very bad

Please explain ………….

3. How do you rate your experience with the mentor in terms of her ability to help you?.
   - Very good
   - Good
   - Somewhat good
   - Neutral
   - Somewhat bad
   - Bad
   - Very bad

Please explain ………….

4. I felt the need for more guidance and help than what *Qudwa* provided
   - Strongly agree
   - Agree
   - Somewhat agree
   - Neutral
   - Somewhat disagree
   - Disagree
   - Strongly disagree

Please explain ………….

5. Why did you participate in Qudwa?
   - Finding answers
   - The need to talk to someone with experience
   - increasing my knowledge
   - Curiosity/new experience
   - Others, please specify ……….

6. The available information about each mentor was enough for you to decide which mentor to choose.
   - Strongly agree
   - Agree
   - Somewhat agree
   - Neutral
   - Somewhat disagree
   - Disagree
   - Strongly disagree

Please explain ………….

7. Did you communicate with more than one mentor? Why?
Please explain ………….

8. How do you feel about the short-term relationship with your mentor?
   - Strongly satisfied
   - Satisfied
   - Somewhat satisfied
   - Neutral
   - Somewhat dissatisfied
   - Dissatisfied
   - Strongly dissatisfied

Please explain ………….

9. Your experience with *Qudwa* could be replaced by a Q&A website, and why?
   - Strongly agree
   - Agree
   - Somewhat agree
   - Neutral
   - Somewhat disagree
   - Disagree
   - Strongly disagree

   Please explain ………….

Communication channels

1. How did you know about *Qudwa*?
   - Twitter
   - Instagram
   - WhatsApp
   - Other, specify ………….

2. What other channels would be helpful for promoting and reaching more girls?
   - Twitter
   - Instagram
   - WhatsApp
   - Other, specify ………….

3. Why did you choose your communication channel?
   - Ease of use
   - I use it a lot
   - Confident using it
   - Privacy
   - Ease of expressing myself,

- Other, specify ……………

4. Did you face any problems with the channel you chose?
   - Yes
   - No

     If yes, please explain ………….

5. What other channels do you prefer to use other than the one used in *Qudwa*?
   …………………………….

6. Did you have any reservations regarding your participation with *Qudwa*?
   - Privacy
   - Connecting with strangers
   - The nature of communication channels
   - No reservations
   - Others, please specify ……………

7. Did you visit the mentors' social media accounts provided on the website?
   - Yes
   - No

     If yes, please explain ………….

Impact of Qudwa

1. How comfortable were you asking the mentor questions?
   - Strongly uncomfortable
   - Uncomfortable
   - Somewhat uncomfortable
   - Neutral
   - Somewhat comfortable
   - Comfortable
   - Strongly comfortable

2. Did you recommend *Qudwa* to others?
   - Yes
   - No

3. Did you share your experience with *Qudwa* with others?
   - Yes
   - No

4. Did you browse other mentors' profiles to increase your knowledge about STEM jobs?
   - Yes
   - No

5. How do you rate the effect of displaying all the mentors from different fields on you to raise your awareness about study and career options?
   - Strongly effective
   - Effective
   - Somewhat effective
   - Neutral
   - Somewhat ineffective
   - Ineffective
   - Strongly ineffective

6. How do you feel after your participation in *Qudwa*?
   - Strongly determined
   - Determined
   - Somewhat determined
   - Neutral
   - Somewhat confused
   - Confused
   - Strongly confused

7. How helpful was the presence of an intermediate person (Aseel) for guiding and communicating in comparison to an automated system?
   - Strongly helpful
   - Helpful
   - Somewhat helpful
   - Neutral
   - Somewhat useless
   - Useless
   - Strongly useless

8. If you had the chance to make changes on *Qudwa* what would you change or add?
   ………………………

C.3   Semi-Structured Interview Questions for the mentors and the mentees

1. Did you ever have a mentor, and do you have any mentors right now?
2. If yes, what impact did being mentored have on your life?
3. How did you get matched with your mentor?
4. What expectations do you have about *Qudwa*?
5. Would you consider your experience with *Qudwa* as successful? Why or Why not?
6. What barriers did you face during your participation?
7. In your opinion what were the elements in the *Qudwa* that were most helpful?
8. Did you have any reservations about the channels of communications?
9. Which channel of communication did you prefer? And why ?
10. How did *Qudwa* fit into your daily activities?

11. How do you feel about your participation in *Qudwa*?
12. What do you think about my role in *Qudwa*?