Exploring E-mentoring: Co-Designing & Un-Platforming

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The underrepresentation of women in the STEM workforce is a global issue. In Saudi Arabia, women constitute 48% of undergraduates in STEM, but their participation in STEM careers remains particularly low. We explored the current state of e-mentoring, and the potential for co-designing to enhance e-mentoring experiences for youth in the Saudi context. We report on how we sought to understand the opportunities, barriers and requirements of e-mentoring for young women in Saudi Arabia through (1) the application of a traditional programme of STEM e-mentoring, (2) workshops on the redesign of e-mentoring, and (3) a co-design activity as the first phase of an alternative e-mentoring process. The study demonstrated that the traits of the participants’ generation had a major effect on the findings; more so than cultural norms. This means that the findings have wider implications than just within the Saudi context. We identify a number of recommendations for designing e-mentoring programmes for young women and teenagers, including un-platforming traditional approaches to e-mentoring and the inclusion of co-design activities as a first step in the e-mentoring process.

Keywords: e-mentoring; co-design; un-platforming; generation Z; teenagers; youth

1. Introduction

It has been widely observed that the participation rate of girls in the fields of science, technology, engineering and mathematics (STEM) is lower than that of boys. In some countries, such as the US, women make up less than 25% of the STEM workforce, despite sustained national, regional and local policy initiatives (Beede et al. 2011; Khare, Sahai, and Pramanick 2013). In German universities, females represent less than 20% of students in STEM subjects (Stoeger et al. 2013). An evaluation of women’s participation in engineering in the UK showed that women represent 11% of the engineering workforce and 15% of engineering undergraduates (Peers 2018). However, a number of countries in the Middle East and North Africa (MENA) region have experienced steady growth in the proportion of women and girls studying STEM subjects in schools and universities (Ramirez and Kwak 2015). Here, over a period of five decades,
participation in STEM subjects in further and higher education has approached gender equality (Ramirez and Kwak 2015). For example, in Saudi Arabia, 48% of undergraduates studying STEM subjects are female (Ministry of Education (Saudi Arabia) 2016). 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. For example, while women in Saudi Arabia account for 16% of the workforce, they comprise just 1% of the engineering workforce and 4% of the information and communication technologies workforce (General Authority for Statistics (Saudi Arabia) 2016). 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). Such factors, in combination with the lack of female role models and the absence of mentoring and support programmes, are likely to have contributed to the low levels of progression of female graduates into STEM professions (Abalkhail and Allan 2015; Al-Asfour et al. 2017).

Recently, there have been many regional and global initiatives to encourage girls to partake in STEM studies and careers; for example, initiatives such as the IEEE Women in Computing Society\(^1\), Arab Women in Computing\(^2\) and the Society of Women Engineers\(^3\). Moreover, a number of awards have been established to recognise women in STEM, including the Women in

\(^1\) [https://www.computer.org/web/communities/women-in-computing](https://www.computer.org/web/communities/women-in-computing)

\(^2\) [http://arabwic.org/](http://arabwic.org/)

\(^3\) [http://societyofwomenengineers.swe.org/](http://societyofwomenengineers.swe.org/)
IT Awards⁴ and L’Oréal-UNESCO Women in Science Awards⁵. Targeted outreach programmes have also been developed to promote girls’ interest in STEM careers and shed light on the value of STEM professions. Girls Who Code⁶ is an organisation that specifically addresses the gender gap in computing by providing after-school programmes and summer courses for girls of different ages to explore and learn about areas such as computer science, robotics and web design. NASA⁷, for example, has developed several such programmes. SISTER is a one-week summer outreach programme that aims to inspire young girls by exploring non-traditional careers with women engineers, mathematicians and scientists. Aspire 2 Inspire is another programme developed by NASA to empower girls by presenting female role models in STEM.

A number of other approaches have been developed to address perceptions that girls are less likely to succeed in a STEM field than boys. These include exposing girls to female role models and mentors in STEM, and raising awareness of their achievements, successes and everyday professional activities. Such mentors perform a considerably larger role than that of simple role models: they encourage, advise, counsel and share their knowledge with the girls involved (Stoeger et al. 2013). Organisations such as Million Women Mentors⁸ promote traditional face-to-face mentoring for women and young girls, to increase their interest in STEM and help them achieve their goals. TechWomen⁹ provides a five-week project-based mentoring

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⁴ [https://womeninitawards.com/](https://womeninitawards.com/)
⁶ [https://girlswhocode.com/](https://girlswhocode.com/)
⁷ [https://women.nasa.gov/outreach-programs/](https://women.nasa.gov/outreach-programs/)
⁸ [https://www.millionwomenmentors.com/](https://www.millionwomenmentors.com/)
⁹ [https://www.techwomen.org/](https://www.techwomen.org/)
programme that targets women in STEM from Africa, Central and South Asia, and the Middle East, connecting them with US-based professional women in STEM. However, the organisation of such face-to-face mentoring programmes faces a number of significant challenges, including the availability of mentors, mentor training and geographical distances. These barriers can be reduced through the use of e-mentoring (Bierema and Merriam 2002; Khare, Sahai, and Pramanick 2013); that is, a ‘computer mediated, mutually beneficial relationship between a mentor and a protégé, which provides learning, advising, encouraging, promoting, and modelling that is often boundary less, egalitarian, and qualitatively different than traditional face-to-face mentoring’ (Bierema and Merriam 2002, 214). Accessibility, efficiency, flexibility and personalisation have all been identified as advantages of e-mentoring over traditional face-to-face mentoring (Khare, Sahai, and Pramanick 2013). E-mentoring involves the matching of mentors and mentees, and regular exchanges between them through computer-mediated communication tools (typically incorporated within a bespoke e-mentoring platform). Such programmes place an expectation on the parties to communicate regularly (i.e. at least weekly) throughout the duration of the programme (Bierema and Merriam 2002). Frequent contact and commitment to relationships are considered to be the pillars of the success and effectiveness of such programmes (Bierema and Merriam 2002; DiRenzo et al. 2010).

Our study is the first to use co-design to help address the gap in understanding of the needs and opportunities for designing e-mentoring for young people. It is also the first systematic investigation of e-mentoring in Saudi Arabia. In this study, we aimed to address two research questions: (1) How effective is a STEM e-mentoring programme in Saudi Arabia? and (2) What are the (a) opportunities for, (b) barriers to, and (c) requirements of e-mentoring for young women? Therefore, we conducted three studies that aimed to investigate and understand e-mentoring for young women. First, we deployed an e-mentoring programme, with the aim of
encouraging high school girls in Saudi Arabia to pursue STEM higher education studies and raising their awareness of STEM career opportunities. The findings from this study led us to take a step back and conduct co-design explorations, with young women, of the perceived barriers to and opportunities for alternative and more flexible forms of e-mentoring. Finally, through reflection on the outcomes of our co-design activities, we developed and piloted the first stage of a new format for e-mentoring with female high school students. Our findings identify a number of design implications for e-mentoring, including the empowerment of mentees by providing them with the opportunity to design their e-mentoring setting as the first phase of e-mentoring itself. Moreover, flexible models of mentoring can be applied to e-mentoring. We refer to this as un-platforming e-mentoring through the design of approaches that facilitate e-mentoring through existing social media technologies and practices.

2. Related Work

2.1 E-Mentoring

A mentor is defined by Zey (1984, 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’. Ensher et al. (2003) described a mentor’s responsibility towards their mentees as falling into three categories: vocational support, psychological support, and role modelling. E-mentoring is based on the application of technology to communication between mentors and mentees. In the literature, e-mentoring programmes have a well-defined structure. Key elements include the defining of programme goals, the matching process (for mentors and mentees), and the management of expectations as to the frequency of mentor-mentee interactions (Bierema and Merriam 2002; Single and Muller 2005).
The matching process differs depending on the goals and characteristics of the participants of the e-mentoring programme. Single and Muller (2005) presented three matching processes: Participant Choice, Uni-Directional Matching and Bi-Directional Matching. In the Participant Choice process, mentees choose from a list of mentors based on their biographical descriptions. Uni-Directional and Bi-Directional matching processes depend on the participants’ preferences, including such factors as profession, personal characteristics or needs of the mentees. In the Uni-Directional process, the mentees’ preferences as to characteristics of the mentors are the basis for matching; in Bi-Directional, the matching is based on the preferences of both the mentors and the mentees.

Published descriptions of e-mentoring programmes demonstrate the use of one or more communication methods. Some programmes have utilised email for communication between mentors and mentees (Lamb and Aldous 2014; Macafee 2012); others have used forums and discussion boards (Redmond 2015; Hooley, Hutchinson, and Neary 2016). Asynchronous approaches have the benefit of flexibility in that they allow participants to respond to questions and participate in discussions at their convenience (Single and Muller 2005; Risquez 2008) and provide a space for discussions to grow and last for longer periods of time (Redmond 2015). In contrast, synchronous communications – for example, e-mentoring programmes that have used chat (Smith-Jentsch et al. 2008; Letourneau et al. 2012) or video conferencing (Bernard et al. 2011; Li, Moorman, and Dyjur 2010) – require scheduling and real-time feedback. Notably, some e-mentoring programmes have combined several methods of communication and given participants the freedom to use all or only some of them. In Lasater et al. (2014), mentors and mentees discussed how would they communicate to maintain their relationship. The programme encouraged the use of journaling and emails. However, one mentor-mentee couple communicated through audio-visual technology (Skype) to create electronic face-to-face
meetings where they could be more empathetic and open in the expression of their feelings. While there are a number of e-mentoring approaches that have used existing platforms, others have developed new platforms customised for their e-mentoring approaches. For example, EMPATHY is an e-mentoring platform that aimed to develop aspiring female managers by connecting them with female managers in the UK (Headlam-Wells, Gosland, and Craig 2005; Headlam-Wells 2004; Headlam-Wells, Gosland, and Craig 2006). It encompassed synchronous and asynchronous means of communication: private and general discussion areas, private synchronous online meetings and internal messaging.

2.2 STEM E-Mentoring for Youth

Despite a recent increase in interest in e-mentoring, the literature describing e-mentoring for young people is not extensive, and is spread thinly across programmes with different objectives and contexts and mentee populations (Wallis et al. 2015). E-mentoring has been utilised in advocating STEM for school students and providing support for STEM undergraduates. Reid et al. (2017) designed a programme to help first-year female undergraduates to choose and develop their 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 programme. Nine out of forty-seven of the mentors were male, and the mentees could place a request to be specifically mentored by female mentors. In addition, the programme 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, and weekly informational emails about mentoring were sent by the programme. By the end of the programme, mentors and mentees had been surveyed and interviewed. Results indicated that online communications were the most utilised method,
even among participants who were located 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. The survey results showed that the major increase was found in confidence about choosing STEM career options (Reid et al. 2017).

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 programme where they were matched with one 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 programme also introduced mentees to other girls of their age who were interested in STEM. Among mentees, there was an initial increase in interest in STEM activities and academic elective intentions as regards STEM subjects. However, while the effectiveness of the programme 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 programme. It was observed that as participants became familiar with the mentors and the platform, the number of interactions decreased. This has been identified in other domains; for example, Stoeger et al. (2013) noted that the drop in participation rates after familiarisation is a common issue among online communities.

Adams and Hemingway (2014) demonstrated an online mentoring relationship that exemplified the student-teacher-scientist relationship. In their study, 170 plant scientists, of whom 105 were female and 65 male, mentored teams of students who were working on science
projects. The relationships lasted from 3 to 12 weeks, and each team communicated with their mentor through a discussion board. Teachers encouraged students to post to and communicate with their mentors through all phases of the project. Based on a content analysis of all conversations, groups were classified into three categories based on mentors’ and mentees’ written messages: low with 1–3 mentor comments and 1–5 student comments; medium with 4–7 mentor comments and 6–10 student comments; and high with more than 8 mentor comments and more than 10 student comments. Results showed that 31% of the groups exhibited low levels of interaction, 36% had medium levels of interaction, and 33% had high levels of interaction. Most mentors (55%) performed a social act with their groups; 26% performed a procedural act, 17% a conceptual act and 2% an epistemological act. The high rates of social acts among mentors were strongly connected to the mentors’ efforts to maintain a relationship with their mentees through the asynchronous platform and to encourage and motivate the young learners.

2.3 Mentoring in Saudi Arabia

Traditional face-to-face mentoring programmes in Saudi Arabia are uncommon, and the existing research literature concerning mentoring in Saudi Arabia is unsubstantial (Abalkhail and Allan 2015; Al-Mutairi et al. 2015; Ghawji et al. 2017). The 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. Ghawji et al. (2017) reported on a Saudi university face-to-face mentoring programme in which students were assigned to a mentor at the beginning of their first year, to provide academic and career-planning guidance and support. However, it was found that many of the mentees never met their mentors. Al-Mutairi et al. (2015) observed benefits in knowledge transfer where mentoring between junior and senior technical professionals was used as one component of an industrial manpower development programme. 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. They conducted semi-structured face-to-face interviews with 44 women (28 from Saudi Arabia and 16 from the UK) who had been in managerial roles for five years or more. The interviewees worked in higher education institutions, except for 15 Saudi managers who worked in the civil service. The findings showed that most of the interviewed UK managers considered mentoring to be an activity that took place in the workplace and had experienced it as such. In contrast, the managers in Saudi Arabia had not experienced any form of mentoring within their workplaces, and regarded mentoring as an activity in which they would engage with male family members.

2.4 Co-Design and Teenagers

Adults and children have been the focus of human-computer interaction (HCI) research, and between these two populations lies the understudied population of teenagers (Fitton and Bell 2014; Yarosh et al. 2011). Teenagers go through fundamental cognitive, biological, emotional and social changes in their transition from childhood to adulthood. Yet their particular needs have to a large extent been overlooked by the HCI and co-design research communities (Fitton, Read, and Horton 2013; Poole and Peyton 2013; Yarosh et al. 2011). In recent years, HCI researchers have started to publish work on their understandings of teenagers (Fitton and Bell 2014; Read and Horton 2016), data collection, and methodologies suited for teenagers (Poole and Peyton 2013; Read et al. 2013) including working with teenagers as designers (Vacca 2017). With their creativity and early adoption and use of technology, teenagers can provide different innovative perspectives when developing digital solutions (Read and Horton 2016).

One rare example of user participation in the design of e-mentoring, though not presented as a co-design activity, was the study by Kalisch et al. (2005), who included mentees (middle and high school students) in the refinement of an e-mentoring website. Web developers visited
schools to give students the opportunity to improve the look (changing colours, adding pictures and rearranging components) of the initial design of a mentoring website. The activity only focused on the ‘visual’ design of their website, aiming to increase the attractiveness of the website to the targeted population (ages 15–21). Therefore, it should be emphasised that co-design activities and participatory design methods have not been utilised in designing e-mentoring approaches with teenagers.

3. Method

We first describe how we sought to understand e-mentoring in the Saudi context; where, as we have already noted, mentoring itself – let alone e-mentoring – is not within the realm of experience of most women or girls. This work originally started with one study; it was then extended to include two further studies that explored the barriers and opportunities identified in the first study. Initially, our objective was to deploy an e-mentoring programme in a standard configuration, where mentors and mentees were matched and regularly contacted each other. The findings from this study showed low levels of engagement from both mentors and mentees. Insights from interviews and focus groups with participants directed us to further investigate the requirements of e-mentoring. Therefore, we expanded our work and conducted co-design workshops with first-year female undergraduates to understand the participants’ expectations of e-mentoring. A key consideration in the choice of first-year undergraduates was that they have had the experience of choosing a STEM field without access to mentoring; in this respect, we identify them as experts through experience. Our exploration showed that participants can, and desire to, design their own e-mentoring experiences. This led us to conduct our third study, in which we developed and piloted the first stage of a new format for e-mentoring. In this study we aimed to validate the findings of the second study with younger girls who were approaching the point of having to choose a STEM field (i.e. our targeted population, the same age group as the
first study). The findings from the three studies have led to several design implications, including the un-platforming of e-mentoring and the need to scaffold the agency of girls in e-mentoring.

Table 1 Summarizes the three studies demonstrating the number of participants, age of participants and the purpose of each study.

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of participants</th>
<th>Age of participants</th>
<th>Purpose of the study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study one: Applying Traditional E-mentoring</td>
<td>22</td>
<td>14-17</td>
<td>Examine the effectiveness of traditional e-mentoring setting in Saudi Arabia</td>
</tr>
<tr>
<td>Study Two: Re-Designing E-Mentoring</td>
<td>30</td>
<td>18-22</td>
<td>Understanding the requirements for e-mentoring through workshops (brainstorming, bodystorming and prototyping)</td>
</tr>
<tr>
<td>Study Three: Co-Design within E-mentoring</td>
<td>15</td>
<td>17-18</td>
<td>Designing an e-mentoring product by participants</td>
</tr>
</tbody>
</table>

3.1 Study One: Applying E-Mentoring

The goals of our initial study were to explore Saudi students’ attitudes and behaviour towards an e-mentoring programme with a standard structure. To accommodate culturally specific factors we supplemented lessons learned from the literature and the recommendations of e-mentoring programmes for young people in other contexts, with our own knowledge and experience. Saudi Arabia is a modern but conservative society; therefore, the privacy of our participants was a key element in our programme design (Al-Saggaf 2011). Family involvement was another key consideration in the design of our study; given the unfamiliarity of the mentoring concept in Saudi Arabia we intended to reassure parents through a mechanism for their own participation. We aimed to understand the feasibility of, and barriers to, the use of online platforms as a vehicle for female Saudi STEM role models to mentor schoolgirls in Saudi Arabia, with the goal of increasing their interest in STEM careers.
3.1.1 Study Design

We used Edmodo\textsuperscript{10}, an existing digital platform that facilitates an educational social network to connect teachers, students and parents. Even though Edmodo is not generally used for e-mentoring, it fulfilled the context-specific requirements of our e-mentoring programme 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. 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. Participants can create, reply to and ‘like’ posts. Mentors and mentees can post to a group and comment on other posts. Parents have access (read-only) to all posts written in their daughters’ groups, using a unique parent code that links each parent with their daughter.

3.1.2 Participants

Our principal participants were the mentees and the mentors; although the parents of the mentees were offered the opportunity to join the programme, none chose to do so. For two months, several approaches were used to recruit mentors and mentees. To recruit mentees, announcements of the programme were made through school visits in Riyadh and participation in Genuino Day 2016\textsuperscript{11}. A call for participation was also distributed through Twitter, WhatsApp, and to university staff and student email lists.

Several approaches were used to recruit mentors: the personal contacts of the lead researcher, contacts made with LinkedIn members with appropriate profiles, and snowball

\textsuperscript{10} https://www.edmodo.com/home

\textsuperscript{11} https://events.kaust.edu.sa/en/Ge16/Pages/home.aspx
recruitment where mentors recommended other mentors. By the beginning of the study, we had recruited 22 Saudi girls aged 14–17 from various provinces in Saudi Arabia, and 8 Saudi women mentors from a range of STEM professions (mechanical engineering, space technology, microbiology and game development). Five of the mentors were based in Saudi Arabia and three in the US.

Our 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. We encouraged our participants to ask questions before and after joining the study. Consent forms were collected from all participants.

3.1.3 Matching Process

It was important to manage expectations by identifying the goal and purpose of the programme and the expected contact frequency (Single and Muller 2005). 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 programme 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, ask questions and engage in conversations to build the relationship with the mentee, and to guide discussions.

We used the Participant Choice matching method (Single and Muller 2005). In doing so we sought to strike a balance between privacy and appropriateness by involving a trusted intermediary (first author) to mediate the connection between mentors and the mentees. We aimed 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 our female mentors we
applied Single and Muller’s (2005) recommendation to not reveal any contact information for the mentors. That is, all the choices made by the mentees were sent to the intermediary (first author). First, we asked our 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, we asked mentors to pick an image of a cat that would represent their work. The use of cat images was also intended to lessen formality between mentors and mentees. Figure 1 depicts the profile and cat image of one of the mentors.

![Figure 1 A short descriptive profile of one of the participating mentors and the associated cat image.](image)

Later, we sent the collected profiles, with associated cat images, to the mentees via email, and asked them to choose their mentors. As our goal was to have no more than five mentees in each mentor’s group, we 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. This was intended to maximise the benefits of information collectively shared 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). This resulted in eight groups of between two and five mentees for each mentor.

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 discussions with their mentees. Reminder emails were also sent to mentees. Use of these kinds of
emails 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 (Stoeger et al. 2013).

3.1.4 Data Collection

To assess the effectiveness of the e-mentoring programme and inform future iterations, we measured participants’ engagement, frequency of interaction and their values and attitudes towards the programme (Single and Muller 2005). A pre-study survey was sent to mentees prior to the beginning of the programme. Quantitative data collected during the study included numbers of posts, replies and likes. We collected all the posts of the participants, most of which were written in Arabic\textsuperscript{12} with only a small number in English. We also conducted a post-study focus group with six mentees, and conducted nine individual interviews with mentors (n = 3), mentees (n = 3) and parents (n = 3).

3.1.5 Findings of Study One

3.1.5.1 Pre-Study Survey: Out of 22 mentees, 10 answered the pre-study survey. The results showed that four of their 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. Participants and their family members had never participated in a mentoring or e-mentoring programme of any form. Participants joined the programme to ‘engage in a new experience’ and ‘make more decisive choices on a college major’. One girl emphasised the lack of family members who could

\textsuperscript{12} All translated text in this work is indicated by an asterisk at the end of the quote.
guide her: ‘My family do not have a scientific background, and I have big dreams and I need those who guide me’.

3.1.5.2 Level of Engagement: We used the number of posts, replies and likes as an indicator of the level of engagement of the mentors and the mentees (Adams and Hemingway 2014). Low (L) engagement was assigned to participants with between 1 and 4 interactions, medium (M) for 5 to 8 interactions, and high (H) to 9 and above (13 was the highest figure recorded). Table 2 summarises the numbers of posts, replies and likes for the three groups of different activity levels. To identify mentors, we 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 AM. 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 BLAM. 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, we were not able to determine whether passive mentees had followed discussions (but not contributed), or whether they were completely disengaged.

While they were asked to spend a minimum of one hour per week interacting in their groups, our results showed significantly lower levels of participation than this, even from the most active participants. High levels of participation in some groups did not always mean high levels of interaction among members of the group. For example, two mentors posted more than once in a single day without any interaction from their group (i.e. replies or likes). Most of the interactions took place within the first month of the study, when mentors introduced themselves and the mentees were curious to know more. Later on, all the groups became inactive except for
group G, where participants were 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 mentee. In group F, three new posts were written, but without any interaction between the members. Mentee ALFL 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 receive any response. After two days, the mentor of that group (Mentor FL) wrote a new introductory post, disregarding the first post by Mentee ALFL.

Table 2 The table presents the number of posts and likes of members of three groups with different activity levels. Group A had the largest number of mentees and their mentor was set to a medium activity level. In group F, there was no interaction between participants as the mentor and the mentee wrote independent posts. Group G was the most interactive group in the study.

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Number of posts</th>
<th>Number of likes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>A1AM</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>B1AM</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>C1AM</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>D1AM</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E1AM</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>FNRAM</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Group A</td>
<td></td>
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A total of 110 posts were created, with significant variety in the content. In this study, our main concern was the low participation and interaction levels between participants. The themes extracted from the posts provide an overview of topics discussed, although a detailed analysis is
beyond the scope of this work. Three themes were identified within conversations: (a) *request*, (b) *inform*, and (c) *engage and motivate*. Different types of requests were made by mentors and mentees, with most being informational in character, concerning the mentors’ studies and careers or resource recommendations (e.g. books, websites or applications). Mentors provided information (*inform*) concerning their studies and careers. They also explained the differences between study majors within a field (e.g. between studying electrical and mechanical engineering). Mentors also discussed their job responsibilities and research fields. Mentors used a range of approaches to engage mentees (*engage and motivate*). These included asking mentees both personal and general questions, and encouraging mentees to research their answers and discuss questions within their groups. Some mentors attempted to establish common interests and make personal connections; some also shared pictures of their labs or work environments in an attempt to engage the girls and make personal connections. Mentors also attempted to facilitate engagement through tasks and projects, in one case by proposing that they design a horror video game, which made the girls excited. In response, the mentor and mentees discussed the characters and story of the video game.

3.1.5.3 *Interviews with Mentors and Mentees*: For our post-deployment interviews, we selected participants who exhibited different levels of participation: one mentor and one mentee with high activity levels, and two mentors and two mentees with medium activity levels. Mentees and mentors with low activity levels did not respond to our requests for interviews. The semi-structured interviews were conducted by phone. Interview questions concerned the respondents’ participation in the e-mentoring programme in general and also focused on the barriers and benefits. Thematic analysis (Braun and Clarke 2006) was applied to the data for all interviews (mentees, mentors and parents). We applied the inductive approach of thematic analysis (Braun and Clarke 2006), a bottom-up method
where data coding is conducted regardless of researchers’ presumptions. It is considered a data-driven methodology because themes originate from the content of the data. The first author studied the data, generated themes and validated them with the rest of the research team. The main themes that emerged were awareness of low level of interaction, communication method as a barrier, and benefits of e-mentoring.

Of the mentors and mentees that were interviewed, all agreed that they had expected more interactions. Mentors had expected the girls to have more questions and requests, while mentees had assumed that mentors would actively initiate discussions and activities. Some said that having more mentees in a group might increase the overall level of engagement. However, despite all communications between a mentor and 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 girls’ low levels of engagement might also be due to girls of this age being overly self-conscious about expressing themselves clearly.

Both mentors and mentees agreed on the difficulty they had experienced in 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 Edmodo’s asynchronous text communication functionality; including the long response times, the time required to write posts and the mentees’ struggles to express themselves. It was evident from the interviews that participants had a strong preference for other modes of communication; they suggested alternatives, including the use of audio or video. Mentor C_H described how she felt the use of text was a barrier both for her and her mentees, saying that from the girls’ point of view, it would mean leaving a ‘trail or a mark’ that was not desirable. Mentor B_M, who was based in the US, explained how the time gaps between responses resulting from the time zone difference and the asynchronous character of the communication produced a disconnection between her and her
mentees. She also described how using a text-based platform required more time (e.g. ‘to actually sit down and think about something to write after a long day of work’) compared to other forms of real-time communication, which could take place during work breaks or early in the morning before work.

Although the levels of interaction were lower than anticipated, mentees exhibited a considerable increase in awareness about 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, many reported not being aware that such careers existed for females in Saudi Arabia. The study also had a positive impact on some girls who had already decided to study a STEM major. 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 is a career option for a computer science major. Another girl expressed relief at discovering that such careers exist for Saudi females:

*Before joining the programme, I was upset because I did not know that such careers 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 ALHM)

Even though the concept of mentoring is not well established in Saudi Arabia, mentors agreed on the importance and the empowering potential of mentoring. None of our mentors reported having been in a mentoring relationship before, either as a mentee or mentor. They described their personal motivation to mentor in relation to their desire or need to have been mentored themselves (earlier in their careers). Mentors believed that their lives and professional
experiences had value to others, and they felt a responsibility to provide hope and encouragement to the younger generation of future female STEM workers.

3.1.5.4 Interviews with Parents: We sent requests for semi-structured interviews to all parents of mentees, and three mothers agreed to participate. Despite the platform’s configuration, none of the parents had actively participated in the programme; therefore, it was essential for us to understand the reasons for this. We were keen to understand parents’ views, opinions and reservations about the idea of e-mentoring. The themes that emerged from the inductive thematic analysis of the parent interviews were appreciation, own struggle and concerns.

These mothers were appreciative of the programme, and stressed the need for and importance of it. One mother said: ‘I wish I had someone to guide me or answer my questions.’* Another mother told us that she was the one who had informed her daughter of the programme, as she saw it as a good opportunity. Throughout the interviews, they shared their stories of the challenges they faced when their daughters were applying to universities. One mother explained: ‘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 available opportunities.’* They also described the significant efforts their daughters put into finding answers to their questions concerning course options. One mother told us how her daughter had attempted to make a detailed comparison between three majors she was interested in studying. She had used all the resources she could find, including websites and university-provided course information, and had even contacted current students who were studying these majors. Another mother said that her daughter had ‘no clue’ about how to find information or whom to ask concerning the field that she wanted to study. Therefore, she (her daughter) had attempted to contact girls and
women who were studying and working in the field, to ask them about aspects that concerned her.

The mothers had some concerns about mentors’ political and religious views, and felt that these topics should not be discussed. They did not feel the need to actively participate in the programme themselves, and explained this in various ways. They wanted their daughters to talk freely; they trusted their daughters and believed that they now lived in an open world in which everything was available to them. They felt that they could not control what their daughters watched and read, or whom they talked to. While the mothers expressed some reservations about the use of video channels, they accepted the potential benefits and recognised that their daughters were already using these to communicate with friends. One mother explained that the differences between generations meant she did not seek to exercise excessive control over her daughters’ behaviour, as she knew that they could do whatever they wanted behind her back. Another mother said that parental participation might occur in cases where parents were not convinced that what their daughter was learning was appropriate, or where they wished to participate in discussions on certain topics. Even though they did not actually participate, knowing that they had the option to was important to them.

3.1.5.5 Focus Group: Six mentees who exhibited different levels of engagement joined a focus group to discuss their participation in the programme and how the experience could be improved. At the beginning of the session, the girls talked about their own processes of seeking information about certain fields or careers (e.g. talking to people, visiting laboratories and reading about the field). They described the challenges they faced in finding professionals to talk to, especially women, and the difficulties they experienced in identifying suitable questions to ask professionals whom they would have no chance of meeting again. 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 to decide whether they wanted to commit to a longer-term relationship. They also demonstrated a preference for not being required to have an exclusive relationship with one mentor, but rather having the freedom to choose whom to talk to and for how long. The issue of the seriousness of the programme was also raised, and they expressed a concern that some girls might waste the mentor’s time or not show up. To this end, mentees suggested applying charges and short-term bans for non-attendance, allowing mentors to rate mentees, and giving mentors the option of not accepting meeting requests from low-rated mentees.

3.2 Study Two: Redesigning E-Mentoring

The results from our initial study indicated that the e-mentoring configuration that was employed had a degree of effectiveness, but was not sufficiently engaging. To build on the findings of our e-mentoring deployment and the subsequent interviews and focus group, we conducted three co-design workshops with female first-year undergraduate students. Our choice of co-design and user participation workshops resulted from two considerations. One goal of user participation in technology design is to elicit knowledge and ideas from expert users who know the problem and have been in the relevant situation. Another goal is to give power and agency to those who are usually ignored in the process (Vines et al. 2013). The benefits of people participating in the design of systems they will use include incorporating their understanding of the challenges and barriers; power and agency will result in successful participation in design. As discussed earlier, our target group is generally considered to be an understudied population; specifically, no studies have been reported on employing co-design or user participation in the e-mentoring context. Therefore, we employed co-design workshops to empower our target population with the aim of gaining a deeper understanding of the perceived barriers to and opportunities for e-mentoring
from their point of view.

The second and third workshops responded to the outcomes of the initial workshop. The three two-hour workshops were conducted weekly over a period of three weeks, with the same group of 30 female first-year undergraduate students (18–20-year-olds) 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.

Different design methods were used in each of the three workshops: brainstorming, bodystorming and prototyping. Participants were asked to complete a 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. All sessions were audio recorded and photographed. All three sessions were facilitated by the first author.

3.2.1 Workshop 1: Brainstorming

In the first workshop, the problem space was introduced to the participants using a one-minute animated video (Figure 2) that was produced specifically for the workshop. The video described a 16-year-old Saudi girl, who was passionate about space science and wanted to study and build a career related to space, but did not know who to ask or where to obtain advice about how to further her ambition. We wanted the participants to define the challenges and factors that contributed to the problem. To avoid overly influencing the participants, the term ‘mentoring’ was not mentioned in the video, nor at any time during the workshop by the facilitator.

Participants were divided into five groups, and discussions around the video and the challenges faced by the girl were held within each group. Each group presented a description to the rest of the participants concerning what they understood from the video and what they felt
were the main problems. Later, each group brainstormed ideas to solve the problem and organised their ideas on paper boards using markers and post-it notes, with which they then presented their ideas to the other groups, as shown in Figure 3.

Figure 2 Screenshots of the animated video presented at the beginning of the brainstorming session.

Figure 3 Brainstorming session where participants used paper boards to demonstrate their ideas. The figure displays the boards of three groups.
3.2.2 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, we used bodystorming as a method to make the concept of mentoring more tangible. Rather than using familiar alternatives, such as personas, participants were asked to play the roles of the mentor and mentee, in order to support their understanding of e-mentoring and the production of ideas for realising it (Schleicher, Jones, and Kachur 2010). A number of different situations were enacted; for example, that of a mentee attempting to contact a busy professional mentor. In one such case, group members initially suggested scheduling meetings, but as the scenario developed they concluded that simply agreeing a day and a time is not sufficient. In the simulated meeting (Figure 4), the mentor and mentee sat silently for extended periods of time, leading the group to conclude that agendas for such meetings should be established beforehand to include topics to be discussed, the length of the session and the mode of communication (e.g. text chat or audio/video conversation).

Figure 4 Developing a scheduling scenario through bodystorming.
3.2.3 **Workshop 3: Prototyping**

In the final workshop, the participants engaged in a process of low-fidelity prototyping using paper-printed mobile screen templates. In this session, the aim was not to produce detailed user interface designs, but to complete our understanding and validate the ideas generated in the previous workshops. Participants were organised into five groups; they were asked to sketch and represent their ideas on the screen templates provided, which they then presented back to the other groups.

![Image of low-fidelity prototypes]

*Figure 5 Low-fidelity prototypes resemble social media applications and platforms.*

3.3 **Study Three: Co-Design Within E-Mentoring**

Our final study aimed to reflect on, and extend, our understanding of e-mentoring gained from both the Edmodo deployment and the co-design workshops with undergraduates. Our observations, that our participants exhibited the ability and understanding to design and set guidelines for e-mentoring, pointed to the potential of co-design activities to scaffold the agency
of girls. We therefore developed a co-design activity by compressing the previous three workshops into a single session, and explored the capacity of our younger participants to design their own approach to e-mentoring.

3.3.1 Study Design

Fifteen schoolgirls (aged 17–18) were recruited from a private school as the study aimed to validate the findings of the second study with participants who would soon go through the experience of choosing a university major. A two-hour co-design session was conducted at the school campus, with the approval and collaboration of the administrators of the school and the parents of the students. The stated goal of the session was to design an e-mentoring service that realised the sort of mentoring experience the participants really wanted. The girls were introduced to the overall concept of mentoring through a short presentation; they were then divided into three groups. Each group was given time to discuss ideas about how they would imagine their mentoring experience. The groups were asked to think about and discuss mentoring from (but not restricted to) different perspectives, such as relationships (e.g. one-to-one or one-to-many), the level of commitment and the mode of communication. After these discussions, they were set the challenge of designing an e-mentoring service as if it were a tangible product to be sold on shelves. Each group was given a cereal box covered with white paper and asked to use it to communicate their design of an e-mentoring product. By the end of the session, each group had created their own e-mentoring product (Figure 6), and they were given the opportunity to present its features and market their product to the other girls. Participants were asked to fill in the same survey used in the undergraduate workshops, with the help and knowledge of their parents. The session was audio recorded and photographed.
3.4 Findings of Studies Two and Three

3.4.1 Pre-Study Survey

The pre-workshop survey results of the second study showed that the majority of participants came from families of low socioeconomic status, and 18 of the 30 participants had a parent who did not complete their high school education. In comparison, 10 out of the 15 participants in the third study completed the survey: the results showed that the participants in this study were of a higher socioeconomic status. Their parents had higher levels of education, with all of them having at least a bachelor’s degree (except for one who had a high school diploma as their highest educational qualification).

Most of the participants (80% for the second study and 60% for the third study) expressed a need for help or guidance regarding their studies and career choices. More than half of the participants (55% for the second study and 60% for the third study) indicated that they did not have a clear understanding of career options, opportunities related to their current major (second study), or the major they wanted to study (third study). More than half of the participants
in both studies (60% for the second study and 60% for the third study) indicated that they did not have a female role model in their life.

3.4.2 Themes

Our analysis of the data for the second and third studies identified similarities in the findings of the two studies. In particular, the inductive thematic analysis applied to the data of both studies gave rise to a number of common themes. Therefore, to avoid repetition we combine the findings of the two studies into one section. The first author examined the data of the second and third studies and identified a number of themes: the need for mentoring, structuring e-mentoring, independence and social media resemblance.

3.4.2.1 The Need for Mentoring: In the second study, the groups in the video/brainstorming activity generally agreed on the main needs of the girl in the video; that she required both informational and moral support and guidance, and a means to establish whether her dream of a career in space science is even possible for a woman in Saudi Arabia. The solution most groups proposed was the connection of young women with professional women in Saudi Arabia through email, messaging, audio, video, or text chat. Other ideas included the provision of resources, reading materials, training, job advertisements and informational broadcasts concerning fields and careers by professionals. In the third study, participants were keen to exemplify how their products were important for students graduating from school. In particular, that they would be a means of continuous support by furnishing access to a pool of professionals who would provide mentoring to help them plan for their future.

3.4.2.2 Structuring E-Mentoring: During the two studies, participants set guidelines and built structures 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 the recognition of mentors.

In the bodystorming workshop (second study), participants discussed how mentors should be the ones to display their schedules and availability, as they would have busy lives. In meeting invitations, mentees would have to propose topics that they wanted to discuss, choose the mode of communication based on options the mentor had specified, and set the length of sessions (suggestions ranged from 15 to 60 minutes). In the third study, participants described their methods of interaction, and how mentees and mentors could communicate in different ways. One group described their design by saying: ‘When you choose a major, the popular people in that major will be displayed. Then you select the person who you have an interest in. You can also select the way you want to chat with them (text, video, audio).’

Another feature that was common between the designs was the ability to publicly share mentoring sessions with others, in what the participants called Live Sessions. In the third study, 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. The designs also included a feature that allowed a mentor to (occasionally) host a group mentoring session. As a girl from one group explained: ‘Mentors can set up a group meeting with many users like in Instagram’s Live feature.’* Another girl (from a different group) remarked: ‘Every month, a group chat is hosted by one of our popular professionals.’* In addition, in the second study live mentoring sessions were suggested in some form by all of the groups: they described these as sessions set up by a mentor and broadcast to her ‘followers’ (mentees).

Participants in both studies proposed penalties and solutions to promote ‘serious’ engagement by mentees. For example, in the second study one proposal that received wide
support was for a mentee who did not show up at three meetings to be banned from scheduling meetings for one month. 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. Two groups in the third study discussed the importance of the voluntary contribution made by the mentors, with one group proposing a small fee for each mentoring session, and another group suggesting a one-time start-up fee for joining the programme. 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 administrative support of the services the girls had designed.

Moreover, in the second study there was significant discussion of how to recognise mentors’ contributions. Some suggested that mentors could be evaluated after each session, leading to a ‘mentor of the month’ status for the highest rated. In addition, it was suggested that mentees could write about how their mentors had contributed to their achievements, and share this on their profiles or social media. Mentees could also invite other professionals to join and become mentors. Ratings and reviews were also proposed in the designs of the third study. One group 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.

3.4.2.3 Independence: It was common to both studies that participants wanted the mentees to initiate the mentoring relationship. That is, they would select the mentors rather than being matched up with them. In addition, they demanded flexible uncommitted relationships. In the second study, participants stressed the importance of first-time meetings being non-committal, and not exceeding 15 minutes. These would be used as the
basis for a mentee to decide whether to initiate a longer-term mentoring relationship or not. 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 a single mentor, and that they should be allowed to choose one or more mentors. They stressed the advantages of being in contact with more than one mentor: to be connected to more people, learn about new ideas and different perspectives, and hear more than one opinion or answer to a question. This would increase knowledge concerning the available careers for women in Saudi. Designs produced in the third study included the idea of browsing mentors and contacting as many as desired. Flexibility and freedom in contacting and communicating with the mentors were also among the notable features. One group mentioned ‘not committed to one mentor’ as one of their special features. Another group described their design by saying: ‘You can log in anytime, you can connect with any mentor, any major, any number of times’.

3.4.2.4 Social Media Resemblance: Familiar concepts such as followers, timelines, likes, live sessions and ratings were common to the two studies. The low-fidelity prototyping workshop led to a number of designs that closely resembled social media applications and platforms, and references to these were made when participants were presenting their designs. For example, when presenting 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, top left.) A group from the third study
described how they would feature popular mentors in live sessions: ‘Every month, we have a group chat with one of our popular professionals’.

4 Discussion

In this work, we started by deploying an e-mentoring platform and programme. As a result of the low interaction and participation levels among participants, we ended up considering a co-design activity. It was readily apparent from the three studies that the participating young women and teenagers were seeking flexible and less committed e-mentoring relationships than those provided by existing approaches to e-mentoring. In this section, we examine these issues further, reflect on our overestimation of cultural differences in Saudi Arabia, and discuss how the unique traits of our study population (the so-called Generation Z) had a major influence on the outcomes of our research. Our findings suggest a need to significantly change the format of e-mentoring by incorporating co-design activities as a first step in e-mentoring and considering approaches to un-platform e-mentoring. Our concluding observation is that appropriately configured e-mentoring has the potential be a pillar in building professional networks for women and helping to develop the social capital of young women in Saudi Arabia.

4.1 Overestimation of Cultural Differences

As we have discussed, the concept of a mentor is new (for both professionals and mentees) in Saudi Arabia, and our research 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). Our deployment of a conventionally configured e-mentoring programme gave rise to a number of undesirable behaviours and qualities. These ranged from low levels of interaction between participants and significant discontinuities in the relationships between mentors and mentees, to an unwillingness of mentees to interact with each other or for parents to participate. It is
reasonable to assume that unfamiliarity with the concept of mentoring was a significant factor in
the low levels of participant engagement. This led to our co-design investigations, which
explored the concept of mentoring itself (not just e-mentoring). The lack of understanding of
mentoring is something that has wider implications, and points to an opportunity to re-examine
the concept of mentoring in order to both explore and co-design it in this context.

From the outset, we were aware of the potentially significant cultural differences,
particularly in relation to the privacy requirements of our female participants (Al-Saggaf 2011).
This was the basis of our selection of text as the only means of communication between
participants in our first study. Yet our findings showed that text communication was perceived as
a major barrier. Participants felt the need for more expressive modes of communication, which
would help them to understand each other and allow them to more readily express their
personalities and characters. Moreover, findings from the second and third studies showed
preferences for a variety of communication modes, including video, audio chat and the use of
livestreaming features. Parents also 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 relatively recent
high rate of Internet and social media usage in Saudi Arabia, which has led to the rapid adoption
of such technologies (Bafakih, Othman, and Dhillon 2016; Winder 2014). Our incorporation of
parental involvement in e-mentoring deployment (first 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. We intended 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 are strangers to them). Although parents had the opportunity to participate,
our results showed that none of the parents felt it necessary to do so. In addition, the need for
parental involvement was not mentioned by girls in our second and third studies, which most likely reflects parents’ high levels of trust in girls’ abilities to self-safeguard (and the girls’ awareness of this).

While our sample size was small, the results are compelling. They point to a need for further investigation of cultural norms in relation to digital communication usage in Saudi Arabia by young Saudi women and girls, and how the perceived cultural differences in contexts such as Saudi Arabia may be overestimated.

4.2 Cultural Dimensions of the Target Age Group

Our findings appeared to be affected less by cultural norms and more by the cultural dimensions of the target age group. That is, many of changes in the mode and format of e-mentoring that our participants identified are likely attributable to the communication preferences and online practices of the so-called ‘Generation Z’. Generation Z are those born in 1995 or later; the successors of the Millennials. They are a generation that have not known a world without the Internet (Bencsik and Machova 2016; Garrick, Pendergast, and Geelan 2017), which makes them distinct, as no other generation has had access to the Internet in their early years (Bencsik, Horváth-Csikós, and Juhász 2016; Garrick, Pendergast, and Geelan 2017). Even though the literature on Generation Z is relatively limited (Shatto and Erwin 2017), their identified characteristics (compared to previous generations) include being: smarter, (more) independent, practical, not afraid of change, able to multitask, able to process information quicker, technologically savvy, always online, and dependent on the Internet as their main source of information (Bencsik, Horváth-Csikós, and Juhász 2016; Igel and Urquhart 2012; Ivanova and Ivanova 2009; Shatto and Erwin 2017). However, they have also been characterised as impatient, not team players, and having short attention spans (Bencsik, Horváth-Csikós, and Juhász 2016; Erjongmanee 2017; Igel and Urquhart 2012; Ivanova and Ivanova 2009).
Our findings show some correspondence to the traits of Generation Z. For example, one theme that emerged from the analysis of studies two and three was independence. Participants desired flexible and uncommitted relationships, the ability to connect with more than one mentor, and the power of initiating mentoring relationships themselves. On a number of occasions, participants mentioned terms and phrases that resonate with their identification as Generation Z: ‘15-min meetings’, ‘not committed to one mentor’ and ‘you can connect with any mentor, any major, any number of times’. In some respects, it could be considered that they do not have the patience required to develop a committed relationship, or that they are too independent to require a continuous relationship. It is also possible that participants consider mentors to be a live ‘source of information’ on the Internet. As the traits of this generation are different from those of previous ones, 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, Horváth-Csikós, and Juhász 2016; Ozkan and Solmaz 2015) and the retail industry (Priporas, Stylos, and Fotiadis 2017). Likewise, there is a space for redesigning e-mentoring to better meet the needs of this new generation.

4.3 Co-Design of E-Mentoring

Our findings suggest a need to shift away from what can now be considered as traditional e-mentoring models and platforms. Previous literature on e-mentoring has emphasised that frequent regular meetings between mentors and mentees and the building of a mentoring relationship are key elements in the structure of e-mentoring programmes (Bierema and Merriam 2002; DiRenzo et al. 2010). On the other hand, e-mentoring programmes – including our own study – still face the problems of mentee dropout and the early termination of programmes (Rhodes et al. 2006; Wallis et al. 2015). We argue that the inclusion of mentees in the design
process, rather than joining a pre-structured e-mentoring programme, might provide one solution to this problem. Participants in our study were able to build a structure for e-mentoring by discussing regular elements in e-mentoring designs: relationship levels, duration and means of communication. In addition, they did not overlook elements that are identified as challenges in maintaining the sustainability of mentoring programmes; for example, recognising mentors’ voluntary contributions (DuBois et al. 2011) and the recruitment of mentors by young people (Rhodes and Lowe 2008). Designs produced by young people in our studies incorporated 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 our studies demonstrated a high level of maturity and an ability to build complete structured 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.

4.4 Un-Platforming E-Mentoring

Participant references to social media and audio/video communication technologies were made on many occasions in our 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. We 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 control visibility. Previous work on biculturalism has presented designs by female teenage Latinas that mainly extended current social media platforms or were built on them (Vacca 2017). Similar to our consideration of un-platforming, Vacca suggested that the process of co-design should focus on developing plugins and extensions rather than standalone designs. Our findings from young female adults (second study) and teenagers (third study) 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 programmes have not been discussed in the e-mentoring context (O’Neill, Asgari, and Dong 2011), this has 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 our un-platformed approach) in online learning. While the platform-based course was found helpful in centralising and focusing on learning objectives and tasks, the less structured learning environment (using loosely coupled media) was proven 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, modes and levels of engagement anticipated, and the goals of the e-mentoring programme. For example, designing an e-mentoring programme for youths 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 with 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
programmes report challenges such as premature termination of relationships between mentors
and mentees (Rhodes et al. 2006), programme dropout (Wallis et al. 2015) and inactive mentors
(Linear 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 that operate at 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.

4.5 E-Mentoring to Build Social Capital

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 study, we faced difficulties in finding Saudi STEM female professionals; not because of a lack of such professionals, but because of the absence of communities and networks of Saudi female professionals. Existing platforms such as LinkedIn helped us find professional women, but we still faced the problem of their visibility. 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.

5 Conclusion

We first described an investigation into e-mentoring in Saudi Arabia, and reported the findings of three studies that helped us to identify design recommendations for applying STEM e-mentoring for young women. We found that young women and teenagers were seeking mentoring relationships that were more flexible, with less commitment. As a result, we discussed several design implications based on these findings. Our findings point to a need to shift the design of e-mentoring models to incorporate co-design activities as a first phase of the e-mentoring process, to increase engagement and give a voice to young women. We also propose the un-platforming of e-mentoring and the development of frameworks that build on existing technologies to facilitate e-mentoring. While our study was deliberately limited to the experiences and needs of young women in Saudi Arabia, the implications are considerably wider. We described how the findings of the three studies were affected less by cultural norms and more by the traits of the participants’ generation. Therefore, we encourage further investigation of these recommendations in different contexts.
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