STEMming the Flow: supporting females in STEM

ABSTRACT

An e-mentoring program was established to support females who were studying or intending to study or work in Science, Technology, Engineering or Maths related disciplines (STEM) and were located in regional, rural or remote areas. Mentors and mentees were matched based on their shared interests, fields of study and area of employment. The mentoring program aimed to support mentees' career development and smoother transitions from study into the workforce by providing an opportunity to develop knowledge and networks necessary to achieve their career goals. Data were collected through pre and post online surveys and semi-structured interviews. This paper describes the experiences of e-mentoring for participants located in rural and remote locations, and shares implications for implementation of e-mentoring, and suggestions for improvement for future e-mentoring projects.

Keywords: e-mentoring, gender, online mentoring, rural and remote, STEM

Attracting and Retaining Females in STEM

Although current statistics report that women are attaining more tertiary degrees than men, there is still a gross underrepresentation of females in certain fields. Few women select Science, Technology, Engineering and Mathematics (STEM) disciplines (Mitchell, 2012) as a focus for their education and career. With an estimated 75 per cent of the fastest growing occupations and high status jobs requiring a strong STEM background (Hackling, Murcia, West & Anderson, 2014; Simon, Wagner & Killon, 2017), it is more important than ever that we encourage and support women to enter the STEM fields. In an attempt to attract and retain females in the STEM disciplines within regional, rural and remotion locations an online mentoring program was established. This paper describes the experiences of the participants in the mentoring program.

The continuing trend of significant underrepresentation of females is apparent in all STEM disciplines in all countries (Gorman, Durmowicz, Roskes, & Slattery, 2010; Marginson, Tytler, Freeman, & Roberts, 2013; Single, Muller, Cunningham, Single, & Carlsen, 2005). This underrepresentation is said to be "both *progressive* (worsening over the course of the higher education) and *persistent* (over time)" (Cronin & Roger, 1999, p. 639). Major efforts over the last three decades to draw more women into STEM fields have resulted in impressive gains in mathematics, statistics, biology, and chemistry but women are still far less likely than men to major in computer science and engineering (Coger, Cuny, Klawe, McGann, & Purcell, 2012; Mitchell, 2012; National Science Foundation, 2011). Interventions to promote STEM to women include programs such as mentoring, providing female role models, and gender specific programs (e.g. Women in Engineering, RoboGals, or Go Girls, Go for IT) which provide girls with real world people who present their own experiences of the industry providing an insight of what might be achieved within different STEM areas. Statistics suggest that while academic achievement is up, the number of women earning bachelor's degrees in STEM fields is still low (National Science Foundation, 2011).

Metaphors such as alternate 'pathways' (Rayman & Brett, 1993); the 'funnel' (Cronin & Roger, 1999); and the 'leaky pipeline' (Blickenstaff, 2005) have been used to describe the decline of females' interest or activity in STEM. This decline occurs over time from primary school to secondary school, into higher education, and finally into employment (Whitney, Gammal, Gee, Mahoney, & Simar, 2013). Cronin and Roger's (1999) funnel metaphor suggested three stages describing the filtering out of females in STEM disciplines:

- Stage 1: 'Access' where females studying STEM subjects in primary school is the same for males, but in the later years of high school fewer females than males choose to study STEM.
- Stage 2: 'Participation' where further shrinkage is evident in the number of females selecting STEM subjects when studying in higher education.
- Stage 3: 'Progression' where the number of females entering into STEM careers is further diminished.

Although general access to STEM seems equitable there are a number of features that are commonly presented when discussing females' decision making about continuing to studying and/or enter a career in the STEM fields (BBC, 2012; Blickenstaff ,2005; Clayton, 2007; Gardner, Sheridan, & Tian, 2014; Kitzinger, Haran, Chimba & Boyce, 2008; Pau, 2009; Quimby & DeSantis, 2006; Rommes, Overbeek, Scholte, Engels, & De Kemp, 2007; Sax, Kanny, Riggers-Piehl, Whang & Paulson, 2015). There is considerable overlap in the findings from authors indicating the following six key elements as having an impact on females' choices:

- females perceptions and misconceptions of the fields;
- the inability of peers, family, and teachers to provide contemporary views on careers in the fields;
- media; such as films, television, magazines, and books, the portrayal of the fields;
- stereotyping;
- lack of role models (in real life and fictional characters); and

- gender bias in curriculum materials (including case studies and images in text books).

Society's "deeply ingrained bias toward boys in maths and science" (Coger, Cuny, Klawe, McGann, & Purcell, 2012, p. 1) has a significant impact on decision-making for girls regarding their choices for study and work. Blickenstaff (2005) suggested that "women leak out more than men" (p. 369) further reducing the pool of females in the STEM areas. Misconceptions about STEM disciplines being "too hard for girls" (Coger et al., 2012, p. 2), STEM fields being male-orientated and a lack of visible role models (Homes, Core, Smith & Lloyd, 2018), do little to inspire women to enter these disciplines.

Consistent findings across studies suggest that girls and women are also underrepresented in science classes, clubs, events, careers, and leisure pursuits (Barton & Brickhouse, 2006; Bell, Lewenstein, Shouse, & Feder, 2009; Homes, Core, Smith & Lloyd, 2018). The number of female students has been in decline in STEM courses in high schools over the past decade (Whitney, Gammal, Gee, Mahoney, & Simard, 2013). Young girls cannot consider opportunities that they do not know exist, do not fully understand, or about which they have false perceptions (Coger et al., 2012; US2020, 2014). Efforts to challenge gender stereotypes must be made (Coger et al., 2012; US2020, 2014) and gender differences should be embraced so that female potential to bring technological innovation in new and creative ways is acknowledged and encouraged (Coger et al., 2012).

Women who have high maths abilities are more likely than men with high math abilities to choose careers in non-math intensive areas. This preference shows up as early as in adolescence (Ceci, Williams, & Barnett, 2009). Early life experiences in elementary school should not be overlooked as an important contributor to future career decisions; yet elementary schools are spending less and less time on science if any at all (Tai, Liu, Maltese, & Fan, 2006; Hackling, Murcia, West & Anderson, 2014).

Even when girls and young women *do* choose to enter STEM disciplines, they often face challenges of limited support as a minority group in their field. They face pre-conceived stereotypes that they are not as strong academically as their male counterparts. A lack of 'critical mass' of women in STEM fields may also lead to dissatisfaction and greater attrition of women scientists (Dresselhaus et al., 1995; Ferreira 2003). Outreach from schools, universities, and industry is paramount in contributing to building STEM self-confidence for females (Chao, 2012). Societal obstacles for women in STEM still exist, but "there is evidence of schools with strong, supportive communities for all students" (Coger et al., 2012, p. 1).

E-Mentoring

Australia and the European Union have completed an audit of a range of international initiatives, tools, and concerns in an effort to increase women's participation in science and technology (Australian Council of Learned Academies, 2013; Cacace, 2009). Mentoring was included as one of the recommended tools to assist in attracting more women into science and technology disciplines. Cacace, (2009) commented that mentoring assisted women to attain leadership positions, increased social capital of the participants, and was "important in creating a better **working environment** (emphasis in original) for women" (p. 177). For females new to STEM or considering entering the field, providing high-achieving female role models who have overcome initial difficulties can have a positive effect (Halpern & Colleagues in Mosatche, Matloff-Nieves, Kekelis, & Lawner, 2013).

"Quality mentorship is uniquely positioned to address the barriers to pursuing STEM careers – the lack of exposure to STEM and the lack of connections to STEM professionals" (US2020, 2014). Many of the world's most successful people have benefited from having a mentor. Rolfe (2012) defined mentoring as "an alliance of two people that creates a space for dialogue which results in reflection, action and learning for both" (p. 20). Benefits of mentoring programs can be seen for the mentor, mentee and also the organisation. Table 1 summarises some benefits that have been highlighted in the research (Author, 2008; Philip & Hendry, 2000; Reid, Smith, Iamsuk, Miller, 2016; Rolfe 2012).

Table 1

Benefits of Mentoring Programs

Mentor	**Mentee**	**Organisation**
Provide feedback	Discuss career aspirations	Cost effective in developing talent
Gain different perspectives	Receive feedback	Enhanced outcomes
Gain visibility	Support to achieve goals	Attract and retain quality staff
Provide support	Development of talent and skills	Re-enthusing plateaued staff
Enhanced leadership and mentoring skills	Gain different perspective	Enhanced staff satisfaction
Act as a role model	Explore strengths	Building a learning organisation
Enhanced communication and teamwork	Network and expand contacts	Higher loyalty
Career satisfaction	Tapping into tacit knowledge	Enhanced socialisation of staff

Quality mentors are an important factor in the mentor success, and mentors who are close in age to student participants have been highlighted as having the most effect (Jarvis, 2001; Liston et.al., 2008). The mentoring relationship is not a one way relationship. Mentors can both support and challenge mentees and can also elicit information or impart information. While mentors listen, share their own story, provide feedback, give advice and refer mentees to useful resources, they take on a number of roles including confidante, catalyst, sounding board, link, role model, teacher, coach, adviser, and guide (Ibrahim, Aulls, Shore, 2017; Rolfe, 2012).

When electronic devices are used to provide the primary contact between mentors and mentees, it is known as e-mentoring (Single & Single, 2005). E-mentoring may also be referred to as online mentoring (Ensher, Heun & Blanchard, 2003), tele-mentoring (O'Neil, 2002), cyber-mentoring (Kasprisin, Single, Single & Muller, 2003), iMentoring (Muller, 2009), or virtual mentoring (Stewart & McLoughlin, 2007), and has been defined as the "use of e-mail or computer conferencing systems to support a mentoring relationship when a face-to-face relationship would be impractical" (O'Neil, Wagner, & Gomez ,1996, p. 39). E-mentoring can occur in a number of ways. It could use the telephone, email, web conferencing (such as Skype or other proprietary software), and it could be in open online spaces or closed online spaces.

Mentoring For Women In Stem In Rural And Remote Locations

The challenges of being a female studying or working in a STEM field are further exacerbated in rural and remote environments. The lack of female STEM role models is even more obvious here than in metropolitan areas.

A NCVER report (Curtis et al., 2012) indicated that students in rural locations have "lower aspirations for post-school study" (p. 7). In their study, they matched university students with year nine students and provided weekly mentoring contact. The goal of the mentoring was to raise the aspirations for the school students to engage in post school studies. The study found that the "[p]articipants who had consistently higher levels of mentoring had a higher score on intention to go to university … [when compared to] those who had received minimal or no mentoring" (p. 21). Erwin and Maurutto (1998) also found that mentoring programs had the impact to improve the experience of female science students during university study.

E-mentoring (Livengood & Moon Merchant, 2004) allows geographical barriers to be eliminated. Participants can be matched with a mentor regardless of their location, and asynchronous communication is possible due to communications taking place via email or online discussion. This eliminates time barriers by which face-to-face mentoring relationships are often challenged (Author, 2008). The potential of e-mentoring to support girls and women to consider and embrace education and careers in STEM fields is significant, particularly in rural and remote areas.

Context

This paper explores the experiences of participants in an e-mentoring program which aimed to support females who were studying, considering studying, or working within STEM related disciplines. In an effort to make a difference and to stem the flow from the 'leaky pipeline' in STEM-related disciplines, a group of female academics working in a regional university in Australia established the GoWEST (Go Women in Engineering, Science and

Technology) project to support females who were located in regional, rural or remote locations and working and studying within engineering, science and technology fields.

With the aid of a grant from industry, an e-mentoring project was established as one of the initiatives to address female underrepresentation in STEM disciplines. This project was one of many GoWEST iniatives and was known as the Aiming for a Brighter Future Program, and its goal was to assist mentees in non-traditional areas of study to overcome barriers to entry and progression in STEM careers.

The mentors and mentees were targeting due to specific criteria. Mentors were females working in STEM related industries, such as energy organisations, government departments at local, state and federal levels, engineering, technology or mining companies, and scientists. The role of the mentor was to support the mentee, share information about their journey in STEM from school and onto their current career, and to assist mentees to develop the skills they would need to achieve their career goals. Mentees were either females in high school or higher education (including mature-aged students) undertaking at least one subject in a STEM area or women returning to work or study or working in STEM areas within rural and remote areas. The mentees came from a variety of contexts including high school students, university students and transitional career women. The mentors were aware that the support required by a high school student, for example, was not the same as the support required by a maturate aged women returning to work or study.

The program was flexible regarding contact method and contact frequency. Because the mentees were all located in rural or remote areas, it was impractical for the mentoring communication to occur face-to-face and so the e-mentoring approach became the focus. Contact was made in a range of methods, including by phone, email, web conference (Skype), online chat, or any other means that suited both the mentor and mentee.

The mentoring project had a five-phase structure. Phase one was the initial planning of the project. The objectives of the project and the target groups were identified, stakeholders were engaged, program evaluation and monitoring were established, timelines were negotiated and a program coordinator or e-mentoring facilitator was employed on a casual basis.

The second phase was the promotion of the mentoring project. Contact was established with target groups to attract and engage participants. Participants were recruited via email through previously established relationships Participants were matched against discipline (e.g. if a student was studying engineering they were matched with an engineer). During this phase, the e-mentoring facilitator also created a mentoring handbook.

The third phase was to prepare the participants for the project. They were provided with a mentoring handbook containing tools and resources to kick start the mentoring relationship. Participants were invited to join a synchronous training and information session which provided information about the guidelines for the project. Separate sessions were provided for the mentees and mentors to explain the project, answer questions and provide some initial tips. The participants were made aware that there was a no blame policy; if the matching did not work, either party could withdraw without prejudice. Mentees and mentors received some tips or principles for success, and it was recommended they keep notes in a mentoring diary which had been provided for them.

The fourth phase was program support to ensure maintenance of engagement by the mentors and the mentees. The e-mentoring facilitator made personal contact with each participant and regular mass communication with all participants to ensure participants remained committed to the mentoring arrangement. The facilitator monitored activity and provided assistance and feedback when necessary. The mentors were provided with a resource called "Take a Minute to Mentor" which was like a desk calendar with thought starters for mentoring conversations.

The fifth and final phase was to conclude the mentoring project and to evaluate its success. Certificates of participation and STEM related resources were provided to the mentees. Gifts and certificates of participation were posted to the mentors. Data were collected from participants for both program evaluation and research purposes.

Method

This qualitative study explored the experiences of participants in a female STEM mentoring program. Purposeful sampling was used to collect the data from the mentoring participants (Coyne, 2997). Data for the project were collected from four sources: a pre-mentoring online survey; a post-mentoring online survey; participant interviews; and an anecdotal diary kept by the project facilitator. Data triangulation was achieved through these multiple data sources (Denzin, Lincoln & Giardina, 2006), which also enhanced the credibility of the findings. Data were analysed using an open coding approach to create common themes for each of the three research questions (Ryan & Bernard, 2003). A cutting and sorting process was used to create the final major themes identified through repetition, similarities and differences. Ethics approval was gained via institutional procedures before data collection.

Both mentors and mentees were asked to complete ten minute pre and post-mentoring online surveys about their experiences in the mentoring program. The anonymous survey data were analysed to evaluate the success of, and to inform future directions of the project, and for research publication. The pre and post survey questions included items about the demographics of the participants. The mentors pre-survey included questions about previous experiences in mentoring programs, their mentoring skills, their attitudes to STEM, and their expectations of the mentoring project. The mentor post survey asked their perceptions about the online mentoring experience including the development of relationships, frequency, and method of contact with mentee, it also asked them to indicate the types of support they provided their mentee, difficulties faced, advantages and disadvantages of e-mentoring, and recommendations for program improvement. The pre and post surveys for the mentees mirrored the questions on the mentor survey. Figure 1 provides a summary of the participants, with the majority (50%) of the participants being mature-aged, the next most common age range was the school leavers, with high school representing the smallest number of participants.

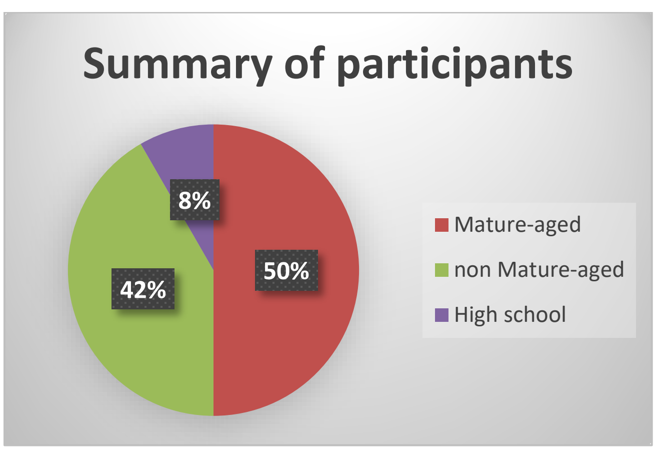

Figure 1. Summary of participants.

Ten semi-structured interviews took place with a selection of volunteer participants including mentors and mentees from the different target groups involved in the project. The mentors came from industry and the target mentees were high school students, university students, and transitional career women. All participants were invited to participate in the interviews. Five mentors and five mentees consented to be interviewThe 30 minute interviews discussed participant experiences of the e-mentoring program and were conducted via phone or Skype web conferencing.

The project facilitator had the role of recruiting mentors and mentees, provide supporting documentation, provide online training and ongoing support for both the mentors and mentees. GoWEST had previously established a large network of industry participants and also high school and university students through previous initiatives such as awards, meet and greet sessions, school workshops, other outreach initiatives and scholarships. Participants were drawn from these networks and contacted via email, social media or phone.They also made regularly contact with each of the participants to monitor the mentoring relationships and activities. The project facilitator's anecdotal diary was used to construct a final project report and included notes on a project timeline, suggestions for improvements, and indicators where blockages occurred, and solutions were raised. The research questions for this project were:

1. What were the female participant's attitudes towards STEM?
2. What were the participant's expectations of the e-mentoring program?
3. What factors contribute to program satisfaction/dissatisfaction?

Findings and Discussion

Twenty-four one-on-one mentoring relationships were established ($N = 48$). All mentors and mentees were female except one male mentor. During the ten month period (February to November) of the project, 6 participants (3 mentoring relationships) withdrew mid-program. The withdrawal of participants was not considered a failure of the program because it is common for mentoring partnerships to dissolve due to differences in values or lack of time. The majority of the mentors were aged between 18 and 40 and the majority of mentees were aged between 18 and 25, however, there were three mentees aged over 50. 23 participants completed the pre-survey, and 15 participants completed the post-survey. The majority of the mentees were studying at university. The ten participants who accepted the invitation to take part in the semi-structured interviews have been identified as Mentor/Mentee A-J in the following paragraphs.

The company who provided the small grant for the project required branding of the project including their company name. During the recruitment of mentors, the company branding deterred some organisations in supporting the project by providing mentors as they were in direct competition with the branding company. The branding also confused some of the mentees when the recruited mentors were not from the company.

It was made clear that the mentee was in the driver's seat of the mentoring relationship, and that their concerns and aspirations were the focus of discussions. They were also requested to prepare in advance for contact where possible, to gain the most from each discourse. In the pre-survey the mentors and mentees indicated the following goals for the project:

- opportunities to develop relevant relationships with industry, university or high schools;
- a chance to enhance their personal development;

- assistance in the process to develop professional career goals;
- networking opportunities to enhance career progression; and
- opportunities to enhance their future employment.

In the pre-mentoring survey mentors indicated that their mentoring experience ranged from no experience to up to ten years of experience. The majority of the mentors had previously participated in some form of mentor training at work. Many mentors also indicated that they have had their own mentors, and this then provided them with a role model on how to be a mentor. The mentors' approaches to mentoring was described by one mentor as '*opening minds*'; helping mentees see the opportunities by learning from the mentor's experience and insight.

The mentors were primarily motivated to participate by a sense of altruism – a desire to give back to the industry and to help younger aspiring professionals to learn from shared experience. For example, Mentor G recognised that she could '*make someone else's journey in these fields a positive experience*' and Mentor F suggested that it '*allows you to see the world through a different set of eyes, and provide an opportunity for satisfaction when your "mentee" meets their challenges and succeeds*.' The mentors had two key expectations of mentees: (a) that there would be a certain level of responsibility/reliability, and (b) a willingness to engage effectively in building the mentoring relationship.

In the pre online survey two of the mentees identified as having unofficial mentors at their workplace. The mentees primarily viewed mentoring as a personal career development opportunity. The three most desirable outcomes of the mentoring relationship for mentees were broadening horizons, building STEM networks, and setting educational/career goals. Mentee A's motivation for participating in the project was to *'expand my network and find more about the practical part of the industry'* and Mentee G valued '*the opportunity to talk with another woman in the field who can help clarify career goals, opportunities, network and discuss study problems, etc.'* The mentees appeared to have higher expectations of mentor availability than mentors believed that they would be willing or able to provide. The remainder of the findings are discussion through the lense of the three research questions.

What were the female participant's attitudes towards stem?

The first research question investigated the participants' attitudes to STEM and explored concepts such as experiences of females working in the STEM field including, challenges and obstacles, factors which encourage women to remain in STEM. When asked what challenges and obstacles are faced by women in STEM fields both mentors and mentees suggested family issues, isolation, managing perceptions, and stereotyping as major challenges. Mentees added that not being taken seriously and having to prove oneself were additional obstacles they had to overcome. Mentee C proffered that '*sometimes male colleagues can be obstructive; sometimes we as women try too hard to prove ourselves and create a barrier that possibly isn't there*.' Mentee D observed that '*some (but not all) males do not appear to believe we have anything useful to contribute, or do not value our advice in the same manner as [that of] a male colleague*.' A similar view was held by Mentor F who has encountered '*disbelief from male colleagues that a female could do the technical work, and be a leader.'* Gender related stereotypes and bias were identified by Want & Gegol (2017) as an explanation of why women are underrepresented in STEM fields. Palumbo (2016) also found that bias, along with a lack of self-efficacy were issues for females in STEM fields.

The other challenges shared by the mentors align with those described in the literature including isolation on the jobsite, small representation, and being undervalued. Azhar and Griffin's (2014) exploration of women in construction found that barriers for females in that industry also included: work/life balance, male dominance, unfair perceptions of women's capabilities, and slow career progression.

While acknowledging the challenge of working as a female in a traditionally male-dominated field, participants were generally very positive about their study and career choices and the opportunities they provided. Mentor A claimed that working in STEM '*forces me to break the stereotypes*' and Mentor B stated that it was '*challenging and stimulating*.' Interestingly one of the mentees also suggested that the challenge of being in the gender minority was in itself rewarding*: 'Being outnumbered by males doesn't worry me. I actually enjoy the challenge.'* However, Rhoton (2011) commented that "Gendered barriers to women's advancement in STEM disciplines are subtle, often the result of gender practices, gender stereotypes, and gendered occupational cultures" (p. 696).

The mentees appeared to be less positive about their acceptance as females. Interestingly, the issue of ageism was also highlighted as additionally challenging; in two cases being too old, and in another, being too young. As Mentee A revealed*, 'It is frustrating, as besides being female I also look young, which results in many "older" males talking down to me and not taking me seriously.'*

When the mentors were asked what factors encouraged them to remain in the STEM field they revealed that it was the intrinsic rewards that kept them there, with responses such as; *'I* *enjoy what I do because it is interesting work with variety and I am largely independent to plan my day/week'* and *'I am here because I like the challenge'*. Mentees can benefit from mentors who have developed resilience and enjoy the challenge of being a minority in the workplace as these women are more likely to be able to provide positivity and practical coping strategies which improve career satisfaction (Dawson, Bernstein, & Bekki, 2015).

What were the participant's expectations of the e-mentoring program?

The second research question investigated the expectations of the participants from the mentoring program and explored the skills required, their motivations for participation, contact method and frequency, and expectations of the outcomes from mentoring relationships from a personal and professional level. The key roles and skills the mentors reported they would need before the project starting included actively listening, building a trusting relationship, and providing clear expectations. During the post-mentoring survey, they reported that actively listening, giving constructive feedback, motivating the mentee, and building mentee confidence were the key roles. However, once the relationships were established, the issues of building relationships (expectations, feedback) became less important as the needs of the mentee (lack of confidence, poor motivation) emerged. The mentees revealed that the skills they believed mentors should have included building confidence and the ability to motivate.

The participants' expectations aligned with the commonly agreed principles that result in successful mentoring found in the literature (e.g. Curtis, Drummond, Halsey, & Lawson, 2012; Rolfe, 2012). Including discussing expectations of the relationship; building trust; being prepared for the meetings/contact and having clear objectives in mind; communicating regularly, and taking the initiative to stay in touch; accepting feedback and advice (and acting on it); and maintaining respect, honesty, and confidentiality in relationships.

No formal e-mentoring space was established. This project left it up to the participants to decide which method of contact was best for them. The majority of contact was via email with telephone being the next most often used method to communicate. It was anticipated that Skype would have been the primary communication medium. However, this was not the case. There were two mentoring relationships where the participants met face-to-face in addition to their online communication. Interestingly, some of the participants asked if there was a shared platform, or if social media spaces such as LinkedIn or Facebook pages could be established to connect with fellow mentors or mentees.

When comparing the data from the pre- and post-surveys the mentors reported that, networking and work-life balance increased in significance, while assisting with STEM knowledge, motivating others, and resourcing fell in importance. When comparing the mentees and mentors, the biggest difference from mentor perspectives were greater importance attached to a work-life balance, creativity, and networking. Work-life balance, mentioned by both mentors and mentees, and the lack of 'family-friendly' positions in STEM fields have been identified as requiring a cultural shift (Weisgram & Diekman, 2014). If the cultural shift occurs and females' perceive STEM fields as being family-friendly, this would enhance their commitment to their field. Lesser importance was attached to active listening, building a relationship on trust and setting clear expectations – each of these were rated highly by the mentees in the pre-mentoring survey.

Within the anecdotal diary, the facilitator noted that at times throughout the program some mentees needed support that exceeded the scope of the mentor role, for example, psychological or career counselling, and welfare support. If this was the case, the mentees were contacted by the e-mentoring facilitator and referred to the university's student support services group. Another observation made by the facilitator was that mentees that were mature-aged often required additional resources and strategies to support them within the project, particularly with the electronic nature of the mentoring and their unfamiliarity with some of the technologies used to support the mentoring dialogue. They asked for strategies to overcome age discrimination, they sometimes failed to follow up on tasks set by mentors, and some also appeared to be unfamiliar with goal setting.

What factors contribute to program satisfaction/dissatisfaction?

The third research question explored the factors which contributed to the satisfaction or dissatisfaction of the mentoring program. With no face-to-face obligations, the e-mentoring program was highly welcomed by students who were in rural and remote locations and/or studying online. Having the mentoring occur in an online space meant that mentees could have mentors in any geographical location. This approach aligned with Author's (2015) study investigating online mentoring for pre-service teachers, and Author's (2008) exploration of the benefits of e-mentoring to support beginning and establishing educators. The online mentoring provided opportunities for the mentees located in rural and remote locations that would not be possible within traditional mentoring. Single, Muller, Cunningham, Single and Carlsen (2005) reported that e-mentoring provides networking and role model opportunities for women in STEM that would not otherwise exist.

While a benefit of online communication (mainly email) is flexibility, this was somewhat negated by synchronous connections such as telephone and skype (and face-to-face) in that both parties needed to be available at the same time, although not at the same place. Making and maintaining contact requires a level of discipline in order to build an effective online relationship. When discussing the benefits of e-mentoring, the convenience of being able to respond to communication asynchronously was outweighed by the difficulties of committing to respond due to the pressure of other work commitments, and the difficulty of establishing relationships using online methods. One participant whose mentoring relationship included both online (email) and face-to-face communication expressed the importance of both modes of contact: *"Email was most effective between face-to-face meetings, and provided an opportunity where both sides could communicate when convenient, amongst other priorities. For this to work though, the face-to-face relationship was also established and maintained."*

Responses to the questions about factors contributing to program satisfaction were varied. Mentors reported satisfaction gained from supporting other females in the field and developing wider networks. They shared their enjoyment in using what they had learnt along their own journey to mentor and give advice to others starting out. A number of mentors also commented on their personal satisfaction gained from working with *engaged* mentees, with one commenting, *"[My mentee's] enthusiasm was contagious. I am so impressed to see this. It is great to see our young scientists!"* Others commented on relationships that were mutually supportive, with both the mentor and mentee benefitting from participation in the program. Mentees listed the flexibility of the program and the feedback they gained as contributors to program satisfaction.

The participants indicated that detractors from satisfaction included the lack of participation or engagement from the mentorship partner, time management challenges for mentors already carrying such heavy workloads, and mismatches of age/personality. Both mentors and mentees highlighted that mild detractors from program satisfaction included technological issues and "*having to drive the mentoring relationship."* Interestingly these detractors are not limited to online mentoring and can be seen in traditional face-to-face mentoring also (see Eby, 1997, Ensher, Heun, & Blanchard, 2003, Author, 2015).

The participants made a number of recommendations for improvements for future delivery of the program. For example, gain permission to provide photos of the participants to share; discuss mentor and mentee expectations, have mature aged mentees matched with mature aged mentors; and provide a specific technology to use for the mentoring discussions.

There was overwhelmingly positive feedback regarding the unstructured mentoring approach from the self-report perceptions of the participants. Due to the small scale of this study and the limited geographical boundary of participants, the results may not be generalisable to other contexts. It was not possible to differentiate between the responses of the different contexts of the mentees e.g. high school student, university student, mature women returning to work due to the small sample size. Future research might consider larger cohorts in the mentee area to see if there is any differentiation between the outcomes of high school students and higher education students. Another limitation of this study is that the data from both survey and interview were self-reported perceptions of the mentoring experience. Rolfe (2006) suggested that when evaluating a mentoring project, "[r]esults may be subjective and difficult to measure" (p. 11).

There are many site-specific, regional, national and international mentoring programs which already exist using both face-to-face and online environments. Most of those programs are limited to either school, university or industry. This e-mentoring is unique in that it has participants from all three contexts, which broadens the findings and implications of the paper. In addition, this paper specifically addresses those people with a double disadvantage in that they are women in STEM and they are located in regional and rural areas, this is also an area where limited research has previously occurred. The next section of this paper will share implications for e-mentoring of STEM females in regional and rural locations.

Implications

In an attempt to increase retention in e-mentoring programs and to maximise participant outcomes, a number of considerations for those establishing an e-mentoring project are provided based on the lessons learned in this project.

Firstly, the appointment of a mentoring facilitator who will establish the mentoring relationships, induct the mentors and mentees into the mentoring project, create mentoring resources, and assist with ongoing planning, training, management, and monitoring of the mentoring process and relationships is vital to the success of e-mentoring. This may include a synchronous session with mentees (and a separate session for mentors) to establish expectations, consistent contact with mentors and mentees to monitor the mentoring relationships and to promote regular dialogue between the participants (perhaps providing stimulus ideas), and to address roadblocks promptly. Follow up, and ongoing communication from a facilitator beyond the initial synchronous sessions could help to maintain momentum within the mentoring program.

Secondly, the branding of the program explored was a grant requirement in this instance. It should be considered that such branding may deter some organisations from supporting the mentoring by providing mentors due to competition between their company and the naming-rights sponsor. Similarly, mentees may be hesitant to participate if they feel that their future employment within the sector may be compromised.

Thirdly, creating an online space or social media page to connect with others in the project could enhance e-mentoring programs. Consideration of an existing platform such as Facebook or Linkedin may also reduce the challenge of finding time amongst other commitments to connect with the program.

Fourthly, clarity around goals, the frequency of contact and clear expectations for mentees and mentors would be of benefit. The creation of a mentoring agreement or contract could assist in aligning expectations in each partnership and across the project as a whole. A Mid-project evaluation may also be of benefit, or a scheduled discussion to evaluate the effectiveness of each partnership. Mentee H revealed that a clearer plan and additional contact details might have enhanced the mentoring relationship: *'In hindsight, it would have been good to get a contact number to enable more direct and personal contact. We failed to make a plan for when we would contact each other, and that caused us to not speak very often by the end.'*

Finally, like most formal or informal mentoring programs, mentors and mentees participated in the mentoring conversations and activities voluntarily. Effective mentoring takes time demands and this workload is over and beyond the normal expectation of their roles, and often extended the work hours of the mentors. Consideration should be given by industry to support STEM mentoring within the existing norms.

Conclusion

This study reported on an online mentoring project established to support females who were studying or intending to study or work in Science, Technology, Engineering or Maths related disciplines (STEM) and were located in regional, rural or remote areas. Mentors and mentees were matched based on their shared interests, fields of study and area of employment. The program aimed to support mentees' career development and smoother transitions from study into the workforce by providing an opportunity to develop knowledge and networks necessary to achieve their career goals.

The online mentoring enabled mentors and mentees from different locations to be matched in a mentoring relationship. E-mentoring overcomes challenges of traditional face-to-face mentoring in that the pool of mentors came come from a wider range of locations, asynchronous discussions can occur at any time and place, and communication devices are often conveniently available in pocket or handbag. The findings from the data indicated that there are benefits of e-mentoring across STEM disciplines in rural and remote areas where access to female mentors within the discipline is limited and then further reduced due to geographical location.

It is clear that significant benefits can be drawn from e-mentoring programs that support women considering entering STEM fields, or who have already taken up study or careers in this area. While benefits for mentees and mentors vary, it is evident that e-mentoring can increase peer support and professional sharing. There is also evidence that e-mentoring in these fields can help to reduce attrition of women in the field and to boost interest and enthusiasm for studying and seeking employment in STEM disciplines, STEMming the flow of females from the leaky pipeline.

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