Balancing the Equation: Mentoring First-Year Female STEM Students at a Regional University

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Abstract

Due to changes to Australia's economic landscape (e.g., falling productivity and the end of the mining boom) and the emergence of disruptive digital technologies, the shape of the Australian workforce is rapidly changing and the development of STEM skills is an imperative. There has been a decline, however, in the number of students studying STEM subjects in senior secondary school, and the underrepresentation of females in many STEM disciplines further compounds the problem. The University of New England is a regional Australian university where a large proportion of students are from rural and regional areas, are mature-aged, and come from low SES backgrounds. Many commence their tertiary studies in STEM with diverse backgrounds, often without the necessary assumed knowledge. A mentoring program was designed to assist female students develop STEM-related study and career goals. Important components of the program included: face-to-face and online training and professional development for participants, two mentors (one academic and one industry-based) per student, accessibility for students studying at a distance, guest speakers, and outreach activities promoting STEM to the wider community. This program could be readily adapted for other cohorts of students (e.g., indigenous students) and expanded (e.g., for all students embarking on STEM studies). The program helped students recognise and address potential roadblocks to a sustained and successful STEM-based career, build confidence in pursuing study and career goals, and develop sound decision-making skills in career planning. For mentors, the program offered STEM-related professional development opportunities. Furthermore, academic mentors reported a positive impact on their approach to STEM teaching as a result of participation in the program.

Introduction

'Disruptive' digital technologies (e.g., machine learning, 3D printing, and crowd-sourcing) are impacting on businesses, institutions and society in general, 'radically changing the way we live, consume and work' (PricewaterhouseCoopers, 2015, p. 9). The importance of developing students' skills in science, technology, engineering and mathematics (STEM) to help address many of Australia's future challenges has been acknowledged nationally by the Federal Government and industry (e.g., Office of the Chief Scientist, 2014; PricewaterhouseCoopers, 2015). As the demand for STEM skills has increased, however, there has been an obvious decline in enrolments in advanced level mathematics and science subjects in senior secondary school (Office of the Chief Scientist, 2012), which means that fewer students have the necessary prerequisites to study STEM-based degrees. With the resulting low enrolments in STEM, retention and progression become fundamentally important. For rural and remote students studying STEM subjects, and the communities to which they belong, this is an even bigger issue because they experience higher attrition rates than other student cohorts (Wilson, Lyons & Quinn, 2013).

Adding to the challenge of developing a workforce with the necessary STEM skills to face Australia's future challenges is a noticeable underrepresentation of women in the STEM disciplines; 'To secure Australia's health and economy into the future, the talents of women in science, technology, engineering and mathematics (STEM) … are vital' (Women in STEMM Australia, 2016). There is a notable loss of females in STEM between the end of university (55% of STEM graduates) and the established workforce (42% employed in STEM-based careers). There is an even greater loss of female graduates in the transition to the workforce in the Prime[1] STEM disciplines, where only 33% of graduates and 12% of the workforce are female (DFEEST, 2012). Furthermore, the proportion of women employed in STEM fields in Australia is low in comparison with other OECD countries (Marginson, Tytler, Freeman & Roberts, 2013). Studies (e.g., Phillips, 2014) show that diversity enhances creativity and innovation; it encourages the search for novel information and perspectives, leading to better decision making and problem solving. Consequently, programs that aim to increase female participation in STEM will provide benefits, not only to individuals and the STEM disciplines, but also to society in general.

Women in STEM

Although the aim of increasing female participation in STEM is important, it is not easily achieved. Societal beliefs, expectations and gender bias have a negative impact on female participation in STEM. Implicit bias is common, even among individuals who reject gender stereotypes. People are more likely to associate STEM with men than with women. Negative stereotypes lower female students' test performances and aspirations for careers in STEM (Hill, Corbett & St. Rose, 2010). Women hold themselves to a higher standard, believing that they have to be exceptional to succeed in 'male' fields. However, when a woman is competent in a 'masculine' job she is often considered to be less likeable (Hill et al., 2010). Competency and likeability are both required for success and so this becomes an issue for women in STEM.

How can we address these expectations and biases that negatively impact on female participation in STEM? Marginson, Tytler, Freeman and Roberts (2013, p. 25) recommended the use of mentoring programs, and course and career counselling to effectively encourage young women to follow STEM pathways. In this paper, we describe the development of a mentoring program that implements these recommendations.

Mentoring

The traditional view of mentoring is that of a one-to-one relationship between a more experienced individual and a less experienced one (Lottero-Purdue & Fifield, 2010; Mathews, 2003). We view mentoring as an interaction that facilitates personal and professional development: a two-way partnership where all parties can benefit. Furthermore, mentoring does not have to be a one-to-one relationship. There are various models for mentoring, including that of joint mentoring, where a mentee may have more than one mentor at a time.

Successful mentoring provides benefits for institutions, mentors and mentees (Cawyer, Simonds, & Davis, 2002; Lottero-Purdue & Fifield, 2010; Savage, Karp, & Logue, 2004). For the institution, benefits include improved staff commitment and retention, improved quality performance and maintenance of institutional culture (Mathews, 2003). A mentor may experience increased self-esteem, recognition and enthusiasm as well as benefiting from

[1] Prime STEM disciplines (including, mathematics, engineering and the physical sciences) are those other than allied health or allied economic STEM disciplines.

increased self-reflection. Finally, the mentee may experience improved self-confidence, career satisfaction, increased visibility and exposure and, importantly, enhanced socialisation within the institution (Angelique & Kyle, 2002). In addition, joint mentoring offers further advantages for all participants, including a broader range of perspectives and resources for the mentee to access, increased networking opportunities for both mentors and mentees, and shared workload for the mentors. Furthermore, if the mentors are not from the same institution, it allows the mentoring relationship to evolve collegially with fresh ideas, thereby avoiding what Campbell and Brummett (2007, p. 51) identify as a danger of perpetuating the status quo.

One challenge to successful mentoring arises when participants in the mentoring relationship are not in the same location or, for various reasons, are unable to meet face-to-face. Mentoring that is facilitated using distance learning techniques and tools is commonly referred to as e-mentoring, and can be synchronous or asynchronous. Viewed as a mutually beneficial relationship, e-mentoring takes place primarily through electronic methods (Ensher & Murphy, 2007). Benefits of e-mentoring include the flexibility to interact regardless of temporal and geographical constraints (Ensher & Murphy, 2007; Knouse, 2001), improved access to mentoring partners, records of interactions and reduced costs (Ensher, Heun & Blanchard, 2003). Furthermore, it ‘lacks the salient visual clues that can trigger stereotypes, biases, and discrimination’ (Ragins & Kram, 2007, p.143). Disadvantages of e-mentoring may include: lack of the full range of communication cues such as body language; the potential for miscommunication, and the need for computer-mediated communication and literacy skills, which may restrict accessibility for some (O’Connor, DuBois & Bowes, 2015).

Context

The University of New England (UNE) has a diverse range of 22,000 students studying on-campus and at a distance. Many students come from lower socio-economic backgrounds, are mature age, and enrol through special entry schemes. Approximately 65% of students commencing tertiary studies in science at UNE enrol in distance (off-campus) mode, with many located in rural and regional areas.

The project described here was designed to assist first-year female UNE students enrolled in STEM disciplines (on and off-campus) to make a successful transition to an ongoing career in these non-traditional areas for women. There were two key objectives:

1. Identify issues that female students enrolled in STEM courses at UNE perceive as possible hurdles to successful progression in their studies and on to a career in STEM.
2. Provide a mentoring program (face-to-face and online) that: (i) assists female students to understand and address issues identified as part of objective 1, and any other issues that they may not be aware of in the early stages of their study/career path; (ii) builds the confidence of these students in pursuing a STEM career, and (iii) supports these students to develop sound decision-making skills in planning a career in STEM.

Components of the Program

Target group

The trimester-long mentoring program was designed to incorporate Marginson et al.’s (2013) recommendations for mentoring, course and careers counselling to encourage young women in STEM, and to address concerns about accessibility issues for rural and regional students. In addition, because first-year students often experience career indecision and related career decision-making difficulties (Morgan & Ness, 2003), the program targeted first-year female students enrolled on and off-campus in STEM and included both academic and industry-based mentors. By encouraging women in their first year of tertiary studies to consider a range of STEM-based career choices and making them aware of challenges they may face in pursuing those career goals, the program aimed to better prepare participating students to make informed decisions about study and career choices.

Expressions of interest, selection and matching

The mentoring program was widely promoted across the university. UNE alumni and local professionals who had studied or were working in STEM-based areas were also contacted. Interested individuals were asked to complete an expression of interest (EOI) containing questions on personal demographics, academic background, employment (mentors) or current degree (mentees), interests, and motivation for participating in the program. Student applicants were asked if they had a preference for a female mentor. In addition, all applicants were asked to identify issues that they thought women pursuing a career in STEM may face.

Twenty-four mentees and forty-seven mentors (nine of whom were male) were selected. Fourteen mentees identified as rural or regional students, one as being of low socioeconomic status, one as an Aboriginal or Torres Strait Islander and nine as the first person in their family to attend university. Each mentee was assigned an academic and an industry-based mentor, with mentors and mentees being matched according to several criteria. A selection committee considered whether the mentee requested a female mentor, the general area of interest, what qualities the mentee was looking for in a mentor, and personal insight into applicant personalities (as many of the applicants were known to the committee members). As the focus of the mentoring relationship was not on students' current units of study, matching according to a mentee's discipline area was not the first priority.

Also of interest were those who did not submit an EOI. In addition to the obvious reason that 'I don't have the time', feedback suggested some academics did not wish to be involved because they felt that the program presented a conflict of interest ('*I can't mentor a student enrolled in one of my courses*'), and was discriminatory ('*What about the male students?*'). Some female students also felt that the program was discriminatory but, of more concern, others thought that the program would not be useful to them because '*I don't know what I want to do in the future*'. In promoting the program, we had explained that no academic would be mentoring any student enrolled in one of their courses and also highlighted the importance of addressing female underrepresentation in the STEM disciplines. In future iterations, the numerous benefits of the program to both academics and students needs to be further emphasised at the time of promoting the program.

Mentoring training

To enhance the mentoring relationships, maximise the likelihood of their success, and ensure maximum uptake by participants regardless of their location, mentoring training was offered in a variety of formats (face-to-face and online). The face-to-face training comprised three half-day sessions, run over one weekend: one session for mentees, another session for mentors and a final session, where mentors and mentees worked together. The objectives of the training sessions were to: facilitate discussion about the issues identified in the EOIs and the potential impact of gender bias and societal beliefs on women in STEM; provide a framework for the mentoring process; offer essential skills for building effective mentoring relationships, and facilitate the first meeting between mentors and mentees. The training workshops and webinars were facilitated by a mentoring expert and were tailored to meet the needs of mentors and mentees, incorporating discussion about issues that women may face in STEM careers. Each participant was provided with a mentoring manual to assist in planning, conducting, and reflecting on their mentoring relationships. Online training was offered to those participants who could not attend the face-to-face workshops. A series of four one-hour-long interactive webinars were held in the evenings over a two-week period. The content in the webinars was similar to that in the face-to-face sessions. These webinars were recorded and made available for any participants who could not attend the workshops nor login during the live webinars. Interestingly, some mentors who had attended the face-to-face workshops also logged-in for some of the webinars in order to reinforce certain concepts, particularly for the final session on communication skills and providing feedback.

Professional development activities for participants

In order to motivate and inspire the female students to consider careers in STEM, several events and resources were developed that allowed students to engage with successful women in STEM. Interviews with successful women in STEM, including the first female graduate of Rural Science at UNE as well as UNE's Vice-Chancellor, were recorded and made available on the program website. They described the challenges they faced as women following non-traditional career paths in STEM and discussed the benefits they had received from mentoring relationships, as mentor and mentee. Other activities provided students with the opportunity to meet with inspiring scientists who had developed successful careers in STEM. A lunch-time meeting was held with a visiting female Fulbright Scholar and a public seminar series was also held to promote the diversity of exciting career opportunities in STEM. Australia's then Chief Scientist, Professor Ian Chubb, and five other guest speakers (male and female) gave presentations. This was followed by a Q&A session. Academics and students from UNE attended, along with high school students, parents, teachers and career advisors. These events provided mentors and mentees with valuable networking opportunities, along with the chance to have discussions with successful scientists from around the world.

Accessibility for students studying at a distance

An important aspect of the program was providing off-campus students with opportunities to participate in the program. Some mentors were also located interstate and overseas. It was important to ensure that training, meetings and other opportunities for professional development were accessible to mentees and mentors who participated at a distance. In addition to the interactive training webinars, the presentations at the STEM seminar series were livestreamed to UNE's study centre in Sydney to enable UNE distance students and other potential students to be involved. Off-campus students could apply for travel scholarships to attend the face-to-face mentoring workshops and the STEM careers seminar series. Regular communication with all participants took place through the following channels:

- A program webpage where participants could access the program information, guidelines for mentors and mentees, the recording of the program launch, interviews with successful women in STEM, presentations of the STEM careers seminar series, and links to a range of other STEM resources.
- Weekly emails to help mentors and mentees stay on track and maximise the benefits from their mentoring relationship. An email was sent out weekly, offering tips on best practice in mentoring, along with useful information about STEM education and career development opportunities.
- A Facebook group designed to help foster relationships between mentees and their mentors in a less formal setting. Via this platform, the participants exchanged news items and interesting information relevant to women in STEM and mentoring.

Program evaluation

At the start of the program, mentees were asked to complete an attitudinal survey to ascertain their awareness of possible challenges they may face in pursuing a career in STEM, and the level of their confidence in facing those challenges and making sound career choices. In addition, mentors and mentees were asked to complete an online survey mid-way through the program to indicate the number and type of interactions they had with their mentoring partners, along with any barriers to participation. This was followed up by a final program evaluation and, additionally, mentees were asked to respond to the same attitudinal questions used at the start of the program. Nineteen academic mentors were interviewed to determine any impacts on their approach to teaching and learning due to participation in the program. Finally, a wrap-up session was held at the end of the program, where mentors and mentees reflected on the benefits and challenges of their mentoring relationship. This session facilitated discussion amongst the participants and allowed them to set short to medium-term goals that would help them maximise the benefits gained from the program.

Results

Thirty-one (68%) of the 45 mentors and 15 (62.5%) of the 24 mentees responded to the final program evaluation. Overall, 93% of mentees and 72% of mentors who responded reported that they were satisfied or very satisfied with the program. Of the mentors, 81% felt that they had benefited from the professional development opportunities and 65% from the personal development opportunities. Finding time for the relationship was identified as one of the biggest challenges by both mentors and mentees. Although 43% of the mentors felt that they had not spent sufficient time with their mentee or were unsure if they had, only one mentor felt that the time they spent with their mentee was not helpful to the student. Furthermore, when asked what was the most valuable aspect of the program, all of the mentees mentioned their mentors, or networking with other women in STEM. As one student commented: "*My first year would have been very different without [my mentors]*."

Identification of issues

As part of the expression of interest (EOI), applicants were asked what *they believed* were the issues facing females who want a career in STEM. The themes that emerged from the responses were:

- *Confidence* – this included issues arising from lack of self-belief, imposter syndrome and the intimidation factor of entering a traditionally male-dominated career pathway.
- *Child rearing* – this related to a break in career as opposed to the discrimination or perception of lack of commitment that working mothers may face.
- *Societal beliefs and expectations* – we defined this as issues relating to a belief in traditional gender roles, for example, women should not be working when they have young children.
- *Gender bias* – we defined this as relating to a belief that women do not inherently possess the skills to succeed in STEM, such as, '*girls suck at maths*'.
- *Sense of belonging* – this encompassed feelings that females don't belong in male-dominated industries purely because they are female but also that STEM is not an acceptable, feasible or obvious career path for females.
- *Sexism and discrimination* – aside from blatant sexism and discrimination, this included issues such as females having to 'out-perform' males to achieve the same gains, a negative view of strong and assertive females, and that productivity indicators are too narrow in definition and are typically dependent on continual employment.

- *Sexual harassment.*
- *Inherent differences between women and men* – this related to issues such as females being less risk-adverse than males and that the individual and competitive nature of scientific research and funding models are less attractive to women.
- *Lack of role models, information on and support for STEM careers.*
- *Job security (exclusive of child rearing).*
- *No issues.*

To assist with the classification of responses into various themes, we defined societal beliefs and gender bias as follows: *societal beliefs* about gender are those beliefs that impose the view that men and women belong in traditional gender roles, regardless of ability, while *gender bias* is based on the conviction that women do not have the skills to succeed in 'traditional' male fields.

Some issues that were raised could be categorized into more than one theme. For example, the idea that STEM-related career paths were male-dominated was mentioned in several contexts. Some respondents stated that this could influence the *confidence* of females going into a STEM-related career. Others viewed it as an issue whereby male dominance could result in females not thinking of STEM as an option, which could be listed under *societal beliefs and expectations* or a *sense of belonging*. A summary of the responses, classified by theme, is given in Table 1.

Table 1. Perceived issues facing females who want a career in STEM as identified by program applicants.

Perceived issues identified in applicant expressions of interest	Total (%)	Mentee (%)	Mentor (%)	
			Male	Female
Child rearing	55	46	38	70
Societal beliefs & expectations	43	54	46	33
Lack of STEM support and role models	30	21	46	30
Sense of Belonging	24	25	31	20
Sexism and/or discrimination	22	8	23	33
Confidence	21	25	8	23
Gender bias	18	21	23	13
Inherent differences	12	8	8	17
Sexual harassment	6	4	23	0
Job security	4	0	0	10
No issues	6	13	0	3

Note: The data indicate the percentage (%) of all (n=67), mentee (n = 24), male mentor (n = 13) and female mentor (n = 30) applicants who identified each issue in their EOI. The group that identified each issue with greatest frequency is highlighted with grey shading.

Whilst the sample sizes are small, the results provide some interesting insights into how different groups of people perceive potential hurdles for women in STEM. Interestingly, 70% of the female mentors (i.e., women already working in STEM) identified child rearing as an issue as opposed to less than half of the mentees (46%) and male mentors (38%). This difference in proportions was statistically significant (χ^2=5.0, df= 2, p=0.08). In fact, for female mentors, child rearing was the most frequently identified issue whereas for mentees it was societal beliefs and expectations, and for male mentors it was societal belief and expectations as well as a lack of role models, information on and support for STEM careers.

Potential issues for females in rural and regional areas were also identified. One mentee, who identified as a rural and regional student, thought that female students in rural and regional schools are less likely to be encouraged in STEM-based subject choices:

> *… many schools and teachers (possibly mainly in rural areas) discourage females taking on science based school subjects. I personally was the only female who completed HSC level physics and chemistry, and one of two who completed advanced mathematics despite there being more females than males in our year group.*

Another believed that employment opportunities were more limited for women in rural and regional areas:

> *… when women leave a job temporarily to have children they are away from the workplace and their position must be temporarily filled by someone else. In a rural area this can prove difficult and employers may decide to employ more males over females for this reason and so females may find it a little harder to get a job and so, may feel discouraged.*

One of the mentors identified two potential issues for females living in rural and regional areas:

- education costs
  "What's the point of studying 300km away, expensive, and besides you'll probably work for only a few years before you marry and start a family. What a waste of money!" This could be a comment many mums and dads have made to their daughters.
- remote work locations
  Roles with industrial placement (industrial chemists, metallurgical engineers etc) tend to be either 'favoured' for male applicants, or are in extremely remote places such as male dominated mining FIFO camps.

Online communication

Seventy-one percent (n=45) of mentors and 58% (n=24) of mentees responded to the mid-program survey that inquired about the frequency and nature of contact that mentors had with their mentees. Although the majority of mentors and mentees were located in the local area, a large proportion of communication between participants took place online. Of the 137 contacts made, 30% were face-to-face, 11% were via Skype, 30% were made through email, 11% by phone, and 18% by messaging or other means. Of the mentees who indicated that they utilized Facebook, 82% percent found the Facebook group's postings useful, and 70% found the weekly email and mentoring tips useful. In contrast, only 33% of mentors stated that they found the Facebook group useful, while a further 30% did not use Facebook at all. Seventy-four percent of mentors found the weekly email useful. Feedback indicated that those students who did not find the weekly email and mentoring tips useful was a result of not having read them all or not giving themselves enough time to adequately read the information and get the most out of it. Two mentors felt that the weekly email occurred too often and were too long.

Mentees

Of the 24 student participants who signed up for the program, 12 completed both the pre- and post-program attitudinal survey. The following summarises the information collected from the surveys in relation to feedback on the program as a whole, and to shifts in attitude with regard to confidence and decision making. Comparing results between the pre- and post-program surveys, the level of agreement with the attitudinal statements increased or stayed the same for most mentees (Table 2). The largest increases related to confidence in making sound and appropriate career choices in the pursuit of career goals, and making contacts with peers and professionals who are studying and working in STEM. The greatest increase came from one mentee shifting from ‘disagree’ to ‘strongly agree’ in her confidence that she would be competitive when applying for jobs *and* in her confidence in making contacts with peers and professionals who are studying and working in STEM.

There were decreases in the level of agreement with attitudinal statements post-program, with the majority of them being a shift from ‘strongly agree’ to ‘agree’. There was one instance of a change from agreement to disagreement and this was in relation to feeling confident in making contacts with peers and professionals who are studying and working in STEM.

Table 2. Mentee attitudes towards potential issues facing women who want a career in STEM collated from pre- and post-program attitudinal surveys.

Question	I	NC	D
I am aware of challenges that I may face as a female pursuing a career in STEM	3	7	2
I am equipped to overcome challenges that I may face in pursuing a career in STEM	5	6	1
I am confident that I can make sound and appropriate career choices in the pursuit of my career goals	7	4	1
I am confident that I will be competitive when applying for jobs	5	6	1
I am confident that I will succeed in my career of choice	2	9	1
I feel confident in making contacts with peers and professionals who are studying and working in STEM	6	5	1
I am optimistic about having a successful career in STEM	4	6	2
I would consider applying for a job that I am very interested in, even if I think I am just short of having achieved the level of skill	4	7	1
I am enrolled in the right degree	3	8	1
I know what I want to do when I finish my current degree	3	7	2

Note: Results show the number of students whose responses increased (I), did not change (NC) or decreased (D) in the level of agreement with the survey statements.

Feedback from the final program evaluation indicated that the mentees found the program useful. The most valued aspect of the program for mentees was the relationship with their mentors, the insight and experience they gained from talking with them, and the networking opportunities: *“I valued being able to meet with my mentor and discuss issues. My mentor encouraged me and helped me gain many contacts within the Ag/Law industry.”* The industry-based mentor provided a valuable additional role model: *“It was amazing talking to someone that is a female engineer that has succeeded and has completed their degree and working in the field.”*

Academic Mentors

Nineteen of the 24 academic mentors were interviewed with the aim of determining whether participation in the mentoring program had an effect on their approach to teaching and learning. The impact was greatest for early-career academics but mid-career and experienced academics also acknowledged a positive impact on their approach to teaching and learning. We classified the responses as *revelations*, *recollections* and *affirmations*, and most responses could be cross-classified as insight into the student experience or self-reflection.

Insight into the student experience

For early-career academics, much of what they discovered about the diversity of students' background and experience came as a revelation to them. For example, one young academic was matched with a mature-aged student, who was already a qualified professional and a mother-of-two. The academic gained a much better understanding of the competing demands that many of our students have to juggle and he also gained insight into the additional challenges that many mature-aged, female and distance students face.

> *… it's really interesting … to have a student talking about all the problems that she's facing on a daily basis and how these have an impact on the student's role. A female student is more likely to have other obligations [in addition to] personal and professional [ones]. This is something that you don't expect when you are just looking at the Moodle page. You are just seeing students and you have no idea if they're 18 or 80 years old. … it changed my demographic view that I had for the students … [many are] at some other point of their lives compared to teenagers. … this had an impact on my teaching style.*

He was also surprised that his mentee, already with a degree and a professional career in another area, suffered maths anxiety.

> *My mentee has a successful career ... She's really confident and … has nothing to prove. Nevertheless, I was surprised to hear that she has a fear about maths. So that was the point that made me think, hold on, this is something that is a bit irrational. How are we going to address this?*

As a consequence, this young academic is making an extra effort to build students' confidence: "*Praise them when they do a good thing. It's something that they don't expect.*"

For distance students, many challenges revolve around the lack of face-to-face contact. The mentoring program provided the mentors with opportunities to consider these challenges through their relationships with their mentees.

> *She was a distance ed student so it was good to see the different challenges that she faced … she was using this mentoring program to find out about careers and work experience … but I'm not quite sure how we provide that information to our off-campus students when they don't have as much access …*

Mid-career academics experienced some revelations but they often commented on the fact that discussions with their mentee had reminded them of things they already knew (recollections) but perhaps hadn't put into practice recently. Discussions with their mentees meant that some academics became more aware of the diversity of challenges facing their students, with a resultant impact on their approach to teaching. For example, some revisited the range of motivations that their students have for studying a particular unit. Some students want to be chemists, for example, while others may be taking a chemistry unit only because it is core to their degree. One academic said that she now includes more applied examples to show the relevance of her discipline to a range of degrees and careers. Other mentors became more

conscious of gender issues, with one commenting that she was more aware of gender imbalance in her class and more conscious of diversity when organising her class to work in groups.
The experienced academics most frequently commented that a lot of what they heard or experienced was affirmation of practices they already had in place. Most academics, however, found that the relationship with their mentee was not a one-way interaction, and they also benefited from the relationship. For example, one commented: "*Seeing others' passion in sciences helped give my own passion for science a boost*".

Self-reflection
The second category of responses related to reflecting on one's style of mentoring, teaching and communicating. Some mentors expressed a lack of confidence in their ability to mentor. The professional development offered (training workshops, webinars and mentoring handbook) played a vital role in addressing these concerns: "*It was good to have the professional development support in place, this boosted my confidence and awareness."*

Some academics said that through their discussions with mentees and other mentors they learnt about alternative ways of teaching that these students found valuable, thereby allowing them to think about alternatives to their own approach to teaching and learning.

> *We talk a lot about what she finds effective about some of her lecturers and less effective about others … makes me think about what I am doing as a lecturer. Am I doing some of those things that she appreciates? Am I doing some of the things that she doesn't like? It makes you think about how you're teaching and how that might affect the students.*

As a result of the professional development offered as part of the mentoring program many academics reflected on their communication styles: "*I'm the kind of person … that's quick to offer advice and a solution. Whereas I think it's important … to give the students the tools that they need to figure it out on their own."*
One new academic has consciously made improvements to how he gives feedback and responds to student requests online. He also found that this training helped in his supervisory relationships with HDR students.

> *[It's] helping me to listen more to what the students are saying … rather than just me going,* "well you should be able to do this" *and actually listening to why maybe they are struggling with particular things … that helps improve teaching and interactions.*

Another positive outcome for some academic mentors was an increase in the frequency of discussions about pedagogical issues with colleagues.

Discussion
The development of STEM skills in Australia's future workforce is a national priority. With the decline in students enrolling in advanced mathematics and science subjects in senior high school, the higher education sector is faced with a number of challenges when trying to address this priority. Additional challenges arise when dealing with rural and regional students, and when trying to address the underrepresentation of women in many STEM disciplines. The mentoring program described in this paper helped encourage and support female students enrolled in STEM-based degrees, and prepare them to deal with the challenges of pursuing a career in STEM through awareness-raising and confidence-building activities.

The most valued aspects of the program for the mentees were the networking opportunities and the relationships with their mentors. Mentees appreciated the opportunity to talk to people already in the field and to learn from their life experiences. Overall, mentee awareness, confidence and optimism in regards to a career in STEM and the potential issues they may face had increased or stayed the same by the end of the program. The few decreases in the level of agreement with attitudinal statements post-program could be viewed in a positive or negative light. For example, an undesirable outcome could be that upon completion of the program a mentee was less aware of what she wants to do because she was overwhelmed by the information she has received. As one student stated: *"My uncertainties regarding my career choice will be the thing that may hold me back."* On the other hand, it could be that a mentee now feels she has many more options available to her and wants to explore different possibilities: *"I am open to considering different career paths as I learn more and find out more about what there is I may be interested in."*

Mentors also benefited from the program. Participating academics were able to take the skills they learnt for successful mentoring and apply them to their teaching. For new academics, the professional development provided them with skills and understanding that may have taken them much longer to acquire (if they acquired them at all). For more experienced academics, it refreshed and affirmed their approach to teaching. In particular, academics, both new and experienced, gained a better appreciation of the diversity of their students' backgrounds, motivations for learning and preferences for different teaching styles.

Although the mentoring program was only run over one trimester, the benefits to mentees and mentors were clear. However, the impact of participation in the program on the mentees' study and career decision making and their progression towards a STEM career will only become apparent in the medium term. For future iterations of the program, a greater emphasis should be placed on encouraging less-confident female students enrolled in STEM to become involved, along with recruitment of a greater proportion of students from low SES and rural and regional backgrounds. This program could be readily adapted for other cohorts of students (e.g., indigenous students) and expanded (e.g., for all students embarking on STEM studies). It could also incorporate second and third-year students, developing past mentees as peer-mentors.

The program could also be readily adapted for other disciplinary areas. The key components of the program, which include academic and professional mentors, training, and online resources, should form the core of any mentoring program for tertiary students (on and off-campus), regardless of the discipline. The mentoring model we have developed would be highly suited for implementation across disciplines such as business and law, creating a synergy between these areas. We are currently collaborating with colleagues from the UNE School of Business to adapt the program to include a focus on entrepreneurship. By incorporating a range of different disciplinary perspectives, an interdisciplinary mentoring program would help break down disciplinary silos in a supportive and collaborative environment, resulting in students with STEM skills being better prepared to face the challenges of working within the businesses, corporations and industries that will need to adapt to Australia's changing economic landscape (Pricewaterhouse Coopers, 2015).

Overall the mentoring program for female students was successful in meeting its primary objective of increasing awareness of the challenges of pursuing a career in STEM for female students (enrolled on-campus or in distance mode), while simultaneously increasing their confidence and optimism in their ability to achieve a career in STEM. A further benefit of the program was that it resulted in academic mentors developing a better understanding and appreciation of the first-year student experience in general, and of the off-campus student experience in particular, leading to a more student-centred focus on teaching and learning in STEM.

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References

Angelique, H., & Kyle, K. (2002). Mentors and muses: New strategies for academic success. *Innovative Higher Education*, *26*(3), 195–209.

Campbell, M.R., & Brummett, V.M. (2007). Mentoring preservice teachers for development and growth of professional knowledge. *Music Educators Journal*, *93*(3), 50–55.

Cawyer, C.S., Simonds, C., & Davis, S. (2002). Mentoring to facilitate socialization: The case of the new faculty member. *International Journal of Qualitative Studies in Education*, *15*(2), 225–242.

DFEEST (2012) Female Participation in STEM study and work in South Australia 2012. Report for the Department of Further Education, Employment, Science and Technology. http://www.statedevelopment.sa.gov.au/upload/science/Female%20participation%20in%20STEM%20March%202013.pdf?t=1462498809110

Ensher, E.A., Heun, C., & Blanchard, A. (2003). Online mentoring and computer-mediated communication: New Directions in research. *Journal of Vocational Behavior, 63*, 264-288.

Ensher, E. A., & Murphy, S. E. (2007). E-mentoring: Next generation research strategies and suggestions. In B.R. Ragins, & K.E. Kram (eds.), *The handbook of mentoring at work: Theory, research and practice* (pp. 299 –322). Los Angeles: Sage

Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics*. Washington, DC: AAUW.

Knouse, S.B. (2001). Virtual mentors: Mentoring in the internet. *Journal of Employment Counseling, 38* (4), 162-169

Lottero-Purdue, P., & Fifield, S. (2010). A conceptual framework for higher education mentoring. *To Improve the Academy*, *28*, 37–62.

Mathews, P. (2003). Academic mentoring: Enhancing the use of scarce resources. *Educational Management Administration & Leadership*, *31*(3), 313–334.

Marginson, S., Tytler, R., Freeman, B., & Roberts, K. (2013). *STEM: Country Comparisons*. Final Report for the Australian Council of Learned Academies.

Morgan, T., & Ness, D. (2003). Career decision making difficulties of first year students. *The Canadian Journal of Career Development*, *2*, 3339.

O'Connor, R., DuBois, D., & Bowes, L. (2015). *e-Mentoring for improving the career planning of youth (15-24): A systematic review.*

Office of the Chief Scientist (2012). *Health of Australian Science*. Australian Government, Canberra.

Office of the Chief Scientist (2014). *Science, Technology, Engineering and Mathematics: Australia's Future*. Australian Government, Canberra.

Phillips, K. (2014). How Diversity Makes Us Smarter, *Scientific American*. Retrieved from http://www.scientificamerican.com/article/how-diversity-makes-us-smarter/

PricewaterhouseCoopers (2015). *A smart move: Future-proofing Australia's workforce by growing skills in science, technology, engineering and maths (STEM).* Retrieved from http://www.pwc.com/gx/en/industries/government-public-services/public-sector-research-centre/australia/smart-move.html

Ragins, B., & Kram, K. (2007). The roots and meaning of mentoring. In B.R. Ragins, & K.E. Kram (eds.), *The Handbook of Mentoring at Work: Theory*, *Research and Practice* (299 –322). Los Angeles: Sage

Savage, H.E., Karp, R.S., & Logue, R. (2004). Faculty mentorship at colleges and universities. *College Teaching*, *52*(1), 21–24.

Wilson, S., Lyons, T., & Quinn, F. (2013). Should I stay or should I go? Rural and remote students in first year university STEM courses, *Australian and International Journal of Rural Education*, *23*(2), pp. 77-88.

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