

**WESTERN SYDNEY
UNIVERSITY**



**Vice-Chancellor's
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**Why Western Women
are Choosing STEM ...or Not**

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Background

The lack of retention and participation of women in STEM fields is a complex and multifaceted issue that causes serious concern because STEM occupations are forecasted to grow at a higher rate (11.5%) in Australia as compared to other jobs (7.5%) over the next five years, and the supply of talent may not meet the labor demandⁱ. Attracting more women to STEM professions might be a viable solution as diversity in the STEM workforce powers innovation and invention which can help to drive Australia's long-term economic growthⁱⁱ. While efforts are being made by both the Australian Federal and state governments to improve women and girls' participation in STEM, they have generally been limited in their focus on recruitment and retention of students, overlooking other fundamental factors that influence STEM identity such as perceived self-efficacy, teacher bias, parental influence, gender roles, bias and stereotypes, gender pay gap and a 'chilly' climate for women in STEM professionsⁱⁱⁱ.

This research project focuses on gathering deeper insight into what school teachers and female STEM professionals believe is important for supporting STEM aspirations in young women to inform practical solutions at the individual level. The project has involved the creation and distribution of online surveys with qualitative and quantitative components, for teachers in schools and female STEM professionals in industry. The project also aimed to survey WSU students however, this did not eventuate due to lack of access. This method has been chosen to canvass the current perspectives of STEM professionals in terms of what attracted them towards the field and perspectives from teachers within NSW secondary schools that encourage or deter STEM subject/career selection. This information will be used to make recommendations for how STEM recruitment can be made more attractive to a greater number of women.

Note: This grant was initially awarded to Ms Wendy Truelove who subsequently left the university. Prof. Kathryn Holmes agreed to complete the project on her departure.

Project Aims

This project will specifically investigate the reasons why women in STEM professions were attracted to STEM study and employment and also the reasons why women might choose NOT to pursue STEM study and careers, from the perspective of women STEM professionals and school teachers.

Method

Two surveys (one for school teachers and one for STEM professionals) were distributed via social media postings, mainly on Twitter, by the primary researcher. The surveys took approximately 10 - 15 minutes to complete which was indicated on the first page of the surveys along with the Ethics' approval number. Features were enabled within Qualtrics, that prevented multiple completions from either a single IP address or the same computer to reduce the chance of duplicate completions, and the survey needed to be completed in one sitting. As such, consent to participate in the study was implied by completing the questionnaires and clicking the '>>' button on the first page of the survey. The teacher survey consisted of 21 items that included 11 close-ended and 10 open-ended questions, and the STEM professionals survey consisted of 29 items that included 10 close-ended and 18 open-ended questions. The only criterion for participation in the teachers' survey was being a school teacher, and in the professionals' survey was being a female STEM professional, which was confirmed via the first question of the respective surveys. The final version of the questionnaires was hosted via Qualtrics online surveys.

Results

School Teacher survey

Forty-seven responses were received, 27 were fully completed surveys while 20 were partially completed. Out of the 27 completed surveys, 22% (6) were from male teachers while 77% (21) were from female teachers. 89% (42) of the responses were received from teachers who either taught a STEM subject or were involved in a STEM program at their school.

While four of the ten open-ended questions have been used to present a comparative analysis with the STEM professionals' survey later in the report, the responses to two of the remaining questions have been briefly discussed below.

*What are the reasons girls do choose STEM subjects and activities at school?
(e.g. consider social factors, perceptions, requirements)*

The teachers mentioned the girls' level of capability and confidence in the STEM subject areas, a strong liking of the subjects, feeling challenged in the classroom, being supported and encouraged, needing STEM subjects to achieve higher ATAR for their chosen university course, witnessing representation of strong female role models in STEM, prior experience/school projects in STEM, or a personal favourite STEM teacher as some of the reasons why girls choose STEM subjects and/or activities at school.

A female STEM teacher wrote:

‘Feeling that they CAN achieve in those subjects - especially with the level of maths required for physics and chemistry. This needs to be normalized from Stage 4 or earlier. Seeing and hearing from strong female role models - e.g. teachers that help convince them they should chase their interests despite the expectations and traditions of society’

What difference(s) have you noticed between boys and girls in their involvement in STEM subjects and activities at your school?

The teachers mentioned a lack of confidence in girls as compared to boys in STEM, observing that they are not as keen to participate in STEM subjects as much as boys and are inclined to pursue the stereotypically feminine STEM careers such as doctors or vets. While girls work well, sometimes even better, in STEM classes as compared to boys, they need mentorship, encouragement and support from their teachers in these subjects.

A female STEM teacher wrote:

‘Girls are less confident. They feel less entitled to be good at STEM. Boys think it is expected that they be that way. Girls are more perfectionists in maths. They don't get initially that mistakes are part of learning in maths...’

STEM Professionals survey

Of the 43 responses received, 23 were fully completed surveys while 20 were partially complete. None of the respondents lived or worked in Western Sydney, nor were they graduates from Western Sydney University. Common themes revealed in their responses to the question – what did they enjoy about their career in STEM included, ‘stimulating’, ‘curiosity’, ‘exploratory’, ‘challenging’, ‘variety’, ‘diversity’, ‘logical’, ‘evolving’ and ‘an intellectual challenge’. While four of the 18 open-ended questions have been used to present a comparative analysis with the school teachers’ survey further in the report, the responses to the some of the remaining questions have been briefly discussed below.

Seven of the open-ended questions were focused on gauging some of the challenges faced by females in studying STEM degrees, what could be done about these challenges and whether they were faced equally, by men and women. The responses were thematically analysed, with 3 primary themes identified in Table 1.

Table 1: Challenges identified by female STEM professionals

Challenges identified	Suggestions for solutions	Were these challenges experienced equally by both men and women in STEM degrees?	
		Yes	No
<i>'Men', 'lack of female role models' and 'unconscious bias': A hostile classroom environment created by mostly male students & mostly male teaching staff</i>	Training male leaders to seek out more diversity; efforts put into making workplaces harassment-free & better unconscious bias training.	<p>“Both genders underestimate women’s ability to perform in STEM”</p> <p>“Depends on dominant gender in workplace - e.g. nursing - men likely experience unconscious bias”</p>	<p>“Plenty of male role models”</p> <p>“Men somehow keep getting promoted even as women are held back”</p>
<i>Limited earning potential, competitive & intimidating environment</i>	Better financial incentives to encourage female students and focusing on community building	<p>“I’m actually not very sure about this but I am aware of both men and women who were put off by elitism in mathematics departments”</p>	<p>“Men thrive more easily in competitive environments, because they are taught socially to put themselves forward and shine while women are taught to put others’ needs before theirs and that it is wrong for them to be ambitious and self-promoting”</p> <p>“Gender pay gap is well established.”</p>
<i>'Subject matter difficulty', 'long contact hours', 'long term commitment', 'large class sizes', 'work-life balance' and 'lack of support' (in school and while making degree/course/specialization choices at university)</i>	Early introduction of concepts in school as early as primary school teachers, mentorship, structuring degrees better to allow balance, flexible working arrangements and incentive for research.	<p>“I think this affects both gender if they decide to make family, while they are doing PhDs”</p> <p>“For women with families this would be a challenge but that comes back to the home, if men stepped up responsibilities at home, this would be of equal challenge to men and women.”</p>	<p>“I feel men would have less distractions, less pressure from Society, so they can focus and study deeper”</p> <p>“Domestic pressure is still higher for women”</p>

Comparisons between school teacher and STEM professional surveys

In this section questions that were common in the two surveys are discussed.

What/who do you think are the major influences on girls' choice of subjects/degree/career (select all that apply)?

As displayed in Table 2 both groups identified the importance of interest in STEM subjects as a key influence on girls' subject choices through school and beyond. Teachers identified more other influences than the STEM professionals themselves, possibly indicating that some of the teacher identified influences are not that important for those females that do go on to STEM careers.

Table 2: Influences on STEM subject and career choices

Influences	School teachers (n=47)	STEM Professionals (n=43)
Interest in that area of study	26	26
Mother	23	7
Teacher at high school	22	7
Perception of the degree	20	1
Father	19	8
The media	16	2
A specific experience or life event	16	9
Course entry mark	11	2
Good employment opportunities	11	9
Others	8	5
Good earning potential	8	7
Family member	5	1
Location of campus	4	2
Teacher at primary school	3	0
Female friend	2	0
Male friend	2	4

What are the reasons that girls don't choose STEM subjects and activities at school?

School teachers responded that there is a stigma associated with females in STEM ('nerdy') and a strong gendering of professions from a young age. They also perceived that girls presented with a lack of confidence in their ability, perceived that the subjects were too difficult and required too much work that did not translate into better results. Also, the school teachers believed that girls lacked interest in STEM subjects.

The female STEM professionals cited the establishment of patriarchal career choices at a young age resulting in a lack of awareness about STEM opportunities. They also perceived that many girls had a lack of confidence in STEM subjects and an unconscious bias against them. The STEM professionals also cited the lack of female role models to look up to or seek support from as an impediment. Also, they perceived ongoing sexism in the workplace with poor job culture and working conditions, resulting in a difficulty in maintaining a work life balance.

In general, at what stages to do you think most girls/women make decisions about whether or not they will pursue study or a career in STEM?

Both the school teachers and the STEM professionals indicated that high school was the most likely stage for females to make decisions about whether to pursue STEM or not, as indicated in Table 3.

Table 3: Stages when decisions are made to pursue STEM or not

Stage	School teachers (n=35)	STEM Professionals (n=28)
Before primary school	0	2
Primary school	4	2
High School (7-10)	20	13
High School (11-12)	7	9
After high school	4	2

Please share your ideas about what could be done at the following stage/area to encourage girls/women to pursue study or a career in STEM

Both groups provided suggestions for strengthening girls' STEM futures at various stages/areas as displayed in Table 4.

Table 4: Suggestions for improving female STEM outcomes

Stage /area	School teachers	STEM Professionals
Home	Parents must challenge stereotypes, stop gendering, become role models for their daughters and challenge the gendering of toys/play material/representation in books	Parents must encourage curiosity & experimentation, challenge stereotypes, stop gendering & hate- talking about mathematics
Primary school	Teachers must instil a passion, must themselves be confident and using fun activities to instil interest + exposure to female role models from a young age	Teachers must instil a passion, must themselves be confident and using fun activities to instil interest
High School (7-10)	Teachers (more female STEM representation) must be well trained & passionate about STEM, make learning fun for students, use real- world projects, & expose students to female role models.	Teachers must be well-trained & passionate about STEM, not characterize students and appreciate all abilities, never discourage a child from pursuing STEM and providing access to female role models
High School (11-12)	Schools must have female STEM teachers, provide early career support, organize mentoring programs, and encourage all students who are interested regardless of perceived abilities	Schools must have well-qualified teachers, provide early career advise & course choice and mentoring programs
In the Media	Media must showcase diversity, challenge gender biases/stereotypes and depict strong female leaders.	Media must showcase diversity, challenge gender biases/stereotypes and depict strong female leaders.
At WSU	Offer mentorships to schools, support new STEM students and provide opportunities to seek support, bridging programs for mathematics & scholarships for rural students, promoting positive female role models	Must address unconscious bias and support the local community <i>“Address unconscious bias, quotas”</i>

Discussion

The school teachers and STEM professionals surveyed for this project agreed on many of the reasons why girls/women do or do not pursue STEM study and careers. They identified the following as the key reasons why girls/women do pursue STEM study or careers:

- Interest and enjoyment in the subject/career area
- Proven ability and confidence to do well in STEM subjects
- Appreciation of the challenging nature of STEM subjects
- The need to take STEM subjects to maximise university entrance scores
- The requirement for STEM subjects for certain university courses
- Exposure to female STEM role models
- Exposure to interesting STEM projects
- Inspiration from a STEM school teacher

Both groups surveyed cited interest in a STEM subject / career area as the major influence on girls'/their decisions to pursue STEM post-school.

The major barriers to choosing a STEM career or further study were:

- The 'nerdy' stigma associated with STEM subjects
- Gendered perceptions of STEM careers established at a young age
- Lack of confidence in ability and the perceived difficulty of STEM subjects.
- Lack of awareness of the range of STEM opportunities
- Lack of female role models in STEM

Also, the STEM professionals working in STEM fields cited persistent sexism in the workplace and a lack of family friendly workplace policies as reasons for their ongoing dissatisfaction with their careers even though they still enjoyed the challenge and interesting nature of their work.

Both groups surveyed agreed that the early years of secondary school (7-10) was the stage of education where firm decisions were made about STEM careers, pointing to the need for careers interventions and outreach activities to occur from Year 7 onwards. Also, this finding points to the need for secondary school teachers to ensure that girls are enjoying studying STEM subjects in early secondary school, as their interest levels in these subjects is a key determinant of the likelihood that they will continue to study in STEM fields in the post-school years.

The surveys elicited response from the school teachers and STEM professionals about what could be done to encourage more girls/women to pursue STEM careers. Both groups emphasised the early role that parents can play in challenging gender stereotypes,

encouraging curiosity and experimentation in young girls and resisting the urge to talk negatively about mathematics in particular. Both groups mentioned the need for teachers in both primary and secondary schools to be passionate and knowledgeable about STEM subjects and to foster interest and enjoyment of these subjects. The STEM professionals highlighted the need for teachers to avoid characterising students based on gender or on their perceptions of student confidence and to continue to encourage all students to participate regardless of their achievement levels, particularly in the early years of high school. The senior years of high school were recognised as a time where quality careers advice is required, potentially involving the use of STEM mentors for girls. The role of the media was recognised as one where the gender stereotypes could be challenged, and strong female leaders could be promoted. The role of the university was seen by both groups as being able to offer mentorship to schools, scholarships and bridging programs in mathematics and science in order to enable girls to be successful in gaining access to university. Once in STEM degrees the STEM professionals noted the importance of industry links to improve employment outcomes, the provision of extra supports in the first year of university such as involving students in networks to meet other female STEM students. Other STEM professionals pointed to the elitist and competitive nature of STEM disciplines at the university level as a significant challenge for young women.

The findings of the surveys of school teachers and female STEM professionals indicate that many of the established barriers for female STEM participation are still prevalent and require ongoing efforts to minimise their impact on the potential futures of girls and young women. The proportion of the Australian population with STEM skills remains highly skewed in favour of males with 92% of the VET STEM qualified labour force and 71% of the university STEM labour force being male. In order to address these inequities a sustained and cohesive strategy is required across early childhood, primary school, high school, VET, university and into the STEM workplace. Such a strategy should involve the countering of damaging gendered stereotypes, increasing the visibility of female role models, modification to STEM curricula to increase female interest and enjoyment of STEM subjects in schools, addressing unconscious bias against females in STEM to increase confidence in STEM capacities, and through the provision of targeted and contemporary STEM careers advice in schools.

References

ⁱ STEM jobs growing almost twice as fast as other jobs (2020)

<https://www.employment.gov.au/newsroom/stem-jobs-growing-almost-twice-fast-other-jobs>

ⁱⁱ Women in STEM decadal plan discussion paper (2019)

<https://www.science.org.au/files/userfiles/support/reports-and-plans/2019/gender-diversity-stem/women-in-stem-discussion-paper.pdf>