

Youth STEM career choices: What's influencing secondary students' decision making

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Concerns are being raised about the increasing demand for science, technology, engineering and mathematics (STEM) graduates exceeding supply. Early adolescence is an especially critical time when our youth are forming beliefs about themselves as learners, along with establishing career related goals. In this qualitative research, we considered the significance of STEM self-efficacy through the lens of social cognitive career theory (SCCT) to investigate the influencers in youth career choices. The study involved interviews with fifteen lower secondary school students, fifteen of their parents and three career counsellors from three faith-based schools in Western Australia. Our research goals were to ascertain the impact of the learning environment on students' STEM career interest and self-efficacy; explore the influence of parents' attitudes to STEM engagement and engagement with career advice resources on students' STEM career interest and self-efficacy; and determine how a career counsellors' awareness and engagement with STEM impacts on students' career interests. The four major themes identified after data analysis were parents' career experiences and students learning achievement influencing STEM career choices; diverse sources of STEM career information; and parents and students valuing STEM careers while envisioning STEM career futures.

Introduction

Career development is a lifelong process and early adolescence is an especially critical time when our youth are forming beliefs about themselves as lifelong learners, while setting academic and career related goals. There is an increasing concern that the future demand for science, technology, engineering and maths (STEM) graduates will exceed supply and there is a crucial requirement to stimulate our youth to view careers in STEM disciplines as attractive, significant, worthy and achievable. After discussing the importance of developing STEM qualified employees, we consider the significance of self-efficacy through the lens of social cognitive career theory (SCCT) and then focus on the role of career counsellors and parents in supporting youth career choices.

STEM education

Across the globe (including the United States, Canada, the United Kingdom, India and Australia) concerns are being raised about the increasing demand for science, technology, engineering and mathematics (STEM) graduates exceeding supply (Archer, Osborne, DeWitt, Dillon, Wong, & Willis, 2013; Buse, Bilimoria & Perelli, 2013; Falco, 2017; Hackling, Murcia, West & Anderson, 2014; Myburg, 2005; Welde, Bernes, Gunn & Ross, 2016). Netherlands researchers van Tuijl and van der Molen (2016) and British researchers Archer et al. (2013) acknowledged that while STEM studies and careers are not appropriate for everyone, the opportunities STEM provides should be drawn to the attention of all children.

In Australia, the Chief Scientist among others, has also raised concerns about our capacity to meet future challenges with highly trained STEM graduates (Office of the Chief Scientist, 2013). His view that 'Science, technology, engineering and mathematics are distinct and complementary approaches to knowledge and practice that have been proven to produce a benefit to society' (p.24) was supported by the Australian Government and further elaborated in the report *Vision for a science nation, responding to Science, Technology, Engineering and Mathematics: Australia's Future*. It was stated in this report that there are 'critical vulnerabilities in our STEM efforts, which need to be addressed if Australia's economic productivity, competitiveness and national well-being are to improve' (Australian Government, 2015a, p. 1). Education and training recommendations in the report included advancing a national STEM in school education strategy, linking teachers and students to STEM professionals in real workplaces, while also supporting citizen science initiatives. Similar initiatives were announced in the Australian Government's *National Innovation and Science Agenda Report* (2015) and also included expanding opportunities for women and other under-represented groups in STEM, a digital technologies element added to the Australian Curriculum, and STEM partnerships to bring scientists and ICT professionals into the classroom.

In Western Australia, a Technology and Industry Advisory Council (TIAC) funded report released in 2014 identified the status of STEM education, STEM challenges, organisations supporting STEM education and barriers to providing support, in addition to developing a number of recommendations (TIAC, 2014). The focus created by this work highlighted the need to consider the factors influencing young people's career choice and their self-belief or self-efficacy regarding their potential for success in STEM careers.

Self-efficacy

To elaborate, self-efficacy refers to individuals' perceptions about their capabilities for learning or performing tasks within specific domains (Falco, 2017, p. 3). According to social-cognitive theory, articulated by Bandura (1997), self-efficacy influences behaviours and environments, while also being influenced by them. Bandura proposed that students with strong self-efficacy are more likely to set goals and create adaptive learning environments themselves. He also maintained that self-efficacy can be influenced by the outcomes of such behaviours and by input from the environment. Bandura (1997) postulated that people acquire their self-efficacy beliefs from four sources: interpretations of actual performances, vicarious (modelled) experiences, social (verbal) persuasion, and physiological indexes (emotional arousal).

Social cognitive career theory (SCCT) (Lent, Brown & Hackett, 1994; Schmidt, Hardinge & Rokutani, 2012) is a recognised model based on Bandura's general social cognitive theory (Falco, 2017) and useful for understanding beliefs and career related choices. SCCT suggests that career choice behaviour is influenced by expected outcomes, interests and career self-efficacy, so that interaction occurs between environmental factors and individual variables on individual's career development. According to van Tuijl and van der Molen, (2016), self-efficacy is mainly determined by personal accomplishments, vicarious learning, social persuasion and physiological states and reactions.

STEM career self-efficacy

The research reported in this paper was framed by social cognitive career theory and as such considers self-efficacy specifically within the context of STEM education and related career choices. Researchers (Falco, 2017; Fouad & Santana, 2017) have described adolescence as a critical time because students are exploring and acquiring academic and career related interests, as well as attitudes and self-beliefs related to their competence in different domains. Middle school was described by Schmidt et al. (2012) as the make or break period for STEM initiatives for students. Within the social-cognitive framework, self-efficacy is regarded as a critical factor for predicting students' engagement and persistence in the STEM pipeline (Falco, 2017; Fouad & Santana, 2017). Two major sources of self-efficacy are described by Falco (2017) as firstly, mastery experiences, maths and science achievement, and secondly, vicarious learning, emotional arousal and verbal persuasions.

Through their meta-analysis, researchers van Tuijl and van der Molen, (2016) identified five perceived factors contributing to low interest: sociological factors related to resources for career choice; psychological factors related to motivation and interest; educational factors; socio-cultural factors; and socio-historical factors. These researchers offer three inter-related aspects as a means towards a possible solution to raise interest in STEM. These are highlight *knowledge* among parents, teachers and children about the STEM field; highlight the *affective value* that is adhered to STEM study; and draw attention to acknowledging the individual agency aspect of *ability beliefs and self-efficacy building*.

Watson (2016) reported discrepancy between students liking STEM subjects and aspiring to STEM careers. He identified four important factors among Australian secondary students which was impacting on their choice or lack of STEM subjects and future STEM career decisions. These were described as lack of confidence; lack of role models; lack of interest; and lack of common sense in school subject choice. Lent (2005) proposed that gender may influence career decisions as the development of self-efficacy and outcomes expectations may depend on how one is socialised. Falco (2017) argued the disparities among post-secondary enrolments may be explained by differences in attitudes (self-efficacy and interests) and exposure to STEM subjects among females and under-represented minority students during secondary schooling.

Career counselling

Early approaches to understanding career development related to individual traits, lifespan changes and goal setting. These were followed by new beginnings focused on more dynamic approaches as the increasing complexity of career development emerged (Amundson, Mills & Smith, 2014). Some research has suggested school counsellors are regarded as gatekeepers of student potential and assist generations to explore the world of work (Schmidt et al., 2012). As the momentum towards STEM career planning increases, so should opportunities for school counsellors to address many aspects of career development, including course selection, promotion of academic rigour, strategic direction, and attention to under-represented groups (Falco, 2017; Schmidt et al., 2016).

Two key areas of counsellor impact in the STEM career space are firstly academic and career counselling, and secondly leadership and advocacy (Schmidt et al., 2012). To achieve these important goals, career counsellors could begin by deliberately working to integrate STEM knowledge into student goal setting by building awareness of current trends and STEM related careers, while also advocating for increasing the number of under-represented populations in STEM careers. Unfortunately, several studies have noted that middle school students do not always receive valuable advice around enrolment in STEM subjects, so there is a strong need to encourage these students to study more challenging STEM subjects for the important impact these have on general academic success (Falk, Rottinhaus, Casanova, Borgen & Betz, 2017; Falco, 2017; Hansen et al., 2017; van Tuijl & van der Molen, 2016). Despite the recognition that vocational education and training (VET) has a role to play in STEM career choices, and that career counsellors include VET options in their counselling, the general conception of a 'STEM career' is university oriented. Career counsellors are well placed to intentionally work to integrate STEM knowledge into student goal setting. In addition to impact on academic achievement, aspirations, decisions and future plans of students, school counsellors can lead and advocate changing school systems to maximise student potential. For this reason, researchers Johnson (2016), Schmidt et al. (2012) and Watson (2016) argued that school counsellors need to increase their awareness of 21st century opportunities, particularly with regards to STEM related information.

Strategies suggested by Schmidt et al. (2012) to increase knowledge of the career counsellor begin with professional development. One recommendation is to become familiar with the SCCT framework (Lent et al., 1994) that recognised the complexity of personal and systemic influences on career development. Familiarity with this framework may enhance school counsellors' awareness of relevant factors as they develop effective interventions. Secondly, while career counsellors possess the skills to provide basic career counselling, they may not have access to current career facts and skill requirements for STEM focused career planning. Thirdly, counsellors may feel challenged when scrutinising their potential career related preferences and devote some time toward self-evaluating their potential level of partiality toward social oriented career fields. Fourthly, counsellors who embrace their leadership role will assist in defining the scope of their influence and create opportunities for improved counsellor services within the school environment. Using collaborative learning and multiple approaches school counsellors may share their knowledge regarding career options and scholarship and internship opportunities (Schmidt et al., 2012).

Alternatively, Canadian researchers Welde et al. (2016) encouraged integrated career education, which infuses career concept and planning services into academic course content, as a possible solution to mitigate the strain on guidance resources, make links with school subject matter, and facilitate student access to career planning services. These researchers believe it possible and practical to successfully integrate career education into intern teachers' courses, and possibly integrate career education into other subjects. This is recognised as a good opportunity to expand student's limited perception of choices, especially in rural settings, and they stress the importance of exciting, engaging

interventions that maximise student's interests, while using developmentally appropriate interventions and technology.

Parental influence

It also appears that students are more likely to choose STEM majors if their parents are in STEM careers (Watson, 2016). Numerous studies have found that parents, and teachers and peers, have an impact on shaping students' attitudes towards science which may then influence future career choices (Archer et al., 2013; Australian Government, 2019; Middleton & Loughhead, 1993; Rogers et al., 2018; Schmidt et al., 2012; van Tuijl & van der Molen, 2016; Zhang & Barnett, 2015). The more parents are perceived as encouraging efforts, the higher students achieve in science and maths (Zhang & Barnett, 2015). Parents set the stage for their child's career ambitions and instil the precursors of career exploration, thus making them essential to science education (STEM) reform (Middleton & Loughhead, 1993; van Tuijl and van der Molen, 2016). Significantly, researchers Archer et al. (ASPIRES Report, 2013) described the amount of 'science capital' a family has as being a key factor in affecting the likelihood of students under the age of 14 aspiring to a science-related career (p. 3).

Important career developmental tasks for adolescents are to recognise their interests, abilities, and values, search for and acquire knowledge about work, and eventually decide upon realistic educational and career pathways (Rogers et al., 2018). This includes building vocational identity which can be described as having a clear, stable and coherent picture of one's career interests, goals and abilities, and that reflects having developed a strong commitment to internalised career goals. Savickas (2002) proposed that the construction of a vocational identity relies on career exploration, planning, decision making and career confidence. Arguably, vocational identity develops through engagement in various career development tasks and is shaped by a range of personal contextual factors (Rogers et al., 2018; Watson, 2016).

Method

This qualitative study, framed by social cognitive career theory, aimed to investigate the factors influencing a group of young people's ideas and choices in relation to STEM careers.

Our research questions were:

1. How does the learning environment impact on students' STEM career interest and self-efficacy?
2. How do parents' attitudes to STEM and engagement with career advice resources influence students' STEM career interest and self-efficacy?
3. How does career counsellor's awareness and engagement with STEM influence students' career interests?

Three faith-based secondary schools were invited to participate in the study. They were purposefully selected for the study as the career counsellors were active and highly regarded in their professional association. Semi-structured interviews were conducted between August and October in 2017, and involved three separate sessions at each school. Firstly, a focus group interview was held with five Year 10 students who were identified and invited to participate by the school's career counsellor, due to their interest in STEM subjects and/or careers. Year 10 students were selected because that is the year in which crucial decisions are made for year 11-12 subjects, which largely determine a career pathway. A focus group interview was subsequently held with this group of students' parents in each school.

The third data set and perspective was obtained from individual interviews conducted with each school's career counsellor. Three separate but related sets of semi-structured interview questions were prepared for the different participant groups (Appendix). Written consent was provided by all participants prior to recording each session in readiness for transcription and later analysis. These semi-structured interviews explored general attitudes to school; interest in future careers; career influencers among the students; career advice, career resources, and knowledge of STEM resources and careers among career counsellors; and parental perceptions of their children's interests and potential future career considerations, their involvement in guiding children's career decisions and awareness of STEM careers. After transcribing the interview recordings, several readings through the data enabled an initial analysis using open coding and then axial coding (Strauss & Corbin, 1990). To ensure triangulation, data sorting was repeated among the researchers to ensure the consistent identification of major themes across the study. Data from the three case studies were amalgamated for analysis.

Findings: Cross case analysis

Tables 1-3 contain descriptive statistics, followed by the amalgamated interview data to reflect the views expressed by all students, all parents and three career counsellors.

Table 1: Student background information

School case	No. students	Gender	STEM career interests
1 Co-ed Catholic	5	3 M, 2 F	Physiotherapy, dentistry, engineering, programming
2 Co-ed Anglican	5	2 M, 3 F	Psychology, general STEM
3 Boys Catholic	5	5 M, 0 F	Engineering

Table 2: Parent background information

School case	No. parents	Gender	Occupations
1 Co-ed Catholic	4	4 M, 0 F	Teacher, dentist, engineer, psychologist
2 Co-ed Anglican	6	3 M, 3 F	Psychologist, chemist, engineer, health, medicine
3 Boys Catholic	5	3 M, 2 F	Engineer, allied health, geologist, teacher

Table 3: Career counsellor background information

School case	School SES score*	No. career counsellors	Gender	Years in role	Qualifications
1 Co-ed Catholic	103	1	M	6	Grad Cert in Counselling (former science teacher)
2 Co-ed Anglican	113	1	F	13	No qualifications in field (30 yrs teaching experience)
3 Boys Catholic	114	1	F	10	No qualifications in field (former teacher in team of 4 counsellors)

* Mean of all schools is 100 and SD is 15

Students

Ten of the fifteen students interviewed were male, and all but three students intended to follow a career in a STEM field, to be consistent with their strengths and interests while attending school. Typical comments included:

I would like to do something engineering related, because it would involve maths and science which I would say are the subjects I enjoy most;

I'm thinking of doing programming, 'cause it involves lots of problem-solving. That's my favourite part of maths.

Most of the information about STEM careers was obtained from career counsellors, classroom teachers and guest speakers, in addition to parents, friends and family. Also, they identified web site visits and career quizzes during class time as sources of STEM career information. Students also appreciated class time to search for information on career websites. Generally, students did not recognise a deep knowledge of STEM among their parents, and all acknowledged parental interest in their future careers.

Parents were described as happy to support, help and encourage their children, and students repeated parental comments such as, '*no problem to change your mind*', '*it's your decision*' and were generally perceived as encouraging students to follow their interests, while one student explained '*your parents probably don't want you to waste your smarts, the same as mine*'. None spoke of any pressure to follow parental careers though one parent had told her son she '*does not think he will enjoy medicine*'. Students generally described their parents and siblings as having the most influence on their career thinking, due to sharing ideas and conversations with them. One student described his father and grandfather as having the greatest influence on this thinking:

I want to go into mechanical engineering. My dad is an electro-mechanical engineer ... my grandad was a mechanical engineer. I've kind of always been influenced to do it because it was kind of my dream.

A more flexible student said she would prefer a career in musical theatre, although she was prepared to study psychology as a back-up. Students were not personally concerned

about gender issues in STEM studies and careers although comments among them suggested they were aware of potential gender stereotyping. Comments included:

There are some stereotypes regarding jobs. Some jobs are stereotyped that's manly jobs and some others are female jobs. Like nursing, it's more, in your head it's more like a woman's job and some jobs more physical than intellectual are considered more manly, masculine jobs.

I think there is a bit, especially for males, being kind of pushed into the sciencey STEM areas. Whereas, girls are kind of pushed away from that.

There's definitely a kick to get women into the STEM fields. But, there's definitely not as many role models to put women into engineering and STEM subjects.

Students indicated they would appreciate more careers support from classroom teachers, with one affirming the approach of one teacher as,

She tells you how you can get creative with chemistry, because she's enthusiastic about chemistry. She thinks you need chemistry for everything, and she gave us a list of all the careers that chemistry is useful for.

Students explained, they would appreciate more guest speakers and a greater focus on technology in class (including *YouTube* clips and online resources).

Students also voiced their concerns about predictions of computers taking over the design process, and the increasing use of robots and automation in industry. They questioned how to prepare for a career now, while knowing that new conditions and demands would emerge during their future careers. For example, a student commented,

We've got to be prepared for the new jobs that, like not everything is going to be the same that it is today and that's what my dad has been drilling into me, that we've got to change with the times.

Career counsellors

All career counsellors perceived their role as a conduit to transfer career pathways information available to the school, onto their students. Descriptive phrases such as '*to introduce alternative pathways to careers*', and '*career advice for upper students*' were shared during interviews. One summed up her approach as

I'm influencing them at this young age and exposing them to as much information as possible and as many opportunities as possible so that they can continue to discover who they really are and what they like, what makes them tick and what they are happiest doing'.

In the three schools participating in the study, counsellors were available to Year 10, 11 and 12 students. In addition, appointments with younger students seeking advice could be requested directly or as a referral from school leaders. It was evident in the interviews that

each school had many avenues available to extend advice to students. For example, all schools included versions of a *Career Week*, links with universities and TAFE, in addition to presentations from guest speakers both on and off school sites. Two counsellors also offered students access to work experience programs.

However, two of the three counsellors indicated that their role was not to prioritise STEM careers and it was instead to successfully transition students from school to their next option. One counsellor explained '*we hear a lot about it (STEM) from universities, but as a school, there's no push*'. Nevertheless, there was still evidence in the interviews of a strong science/STEM focus in each school, with STEM opportunities highlighted, a focus on the mining industry and events offered as conduits of STEM information and the resources provided by counsellors. In addition, one school specifically employing a STEM promotion officer.

Counsellors look for evidence of strength in maths, science and English, and encourage students to study these subjects at the highest levels. One counsellor expressed his concerns about upper secondary school maths and stated, '*we have a big problem in the fact that maths is no longer compulsory*'. Another expressed pleasure that a digital technologies curriculum had been added to the STEM course selections. Counsellors also look for evidence of creativity, innovation, '*thinking outside the box*' and they consider any evidence of tinkering, pulling things apart, a sense of curiosity and '*looking for reasons why*' as significant indicators of STEM potential. Counsellors appreciated STEM subject teachers speaking with their students about careers in the field and recognised active science teachers who encouraged STEM immersion and careers at their schools.

When reflecting on their own STEM knowledge, two of the three career counsellors were confident they had sufficient access to appropriate resources, which included staying in touch with their own mentors in the field. The third counsellor, however, had recognised gaps in her knowledge so she had attended a STEM skills professional development session and regularly subscribed to *Careers Education* and university subscription lists.

Furthermore, the participating counsellors recognised parents as the greatest influence on student careers, although one counsellor expressed the view that most parents did not feel equipped to help their own children and often advised them about what they 'needed' to do, rather than what they enjoyed doing. She commented,

The vast majority of what I see is that they don't feel equipped to advise their children, generally. There are a third who are totally switched on, engaged and understand the process, and do a lot of research themselves, but again, a lot of it is totally career ended.

For this reason, she makes a deliberate effort to converse with parents as opportunities are presented. Based on the evidence within a recent student survey conducted in their school, another counsellor had the view that strong maths/ science/ IT teachers also had a strong influence on student choices and as such a greater input from classroom teachers was encouraged.

Parents

Parents described their own child's strengths and interest with many acknowledging these same strengths were evident within their extended families. Several parents identified the probable career field their children were likely to follow as similar to their own. Others suggested that their child had not received sufficient information to make definite choices. Parents commented,

(Jack) would go into something in the science/ technology world. Information technology in some form. There are things that he obviously loves; computing, he has put together his own computer at home, and robotics, all those things.

and:

I think he just decided that he wanted to do engineering, and that was it.

All parents expected their child to enrol at university on completing secondary schooling and recognised the importance of future STEM career choices.

All parents considered themselves as influential to some degree in guiding their children towards future careers and one commented,

... the dilemma that my son faces is, I'm an engineer, my brother's a family doctor, my other brother's an ENT surgeon, my wife's a dentist and my sister is a maths teacher. They've got science all around them and both of my boys are very strong in the maths and science.

Parents recognised and valued their role as providing encouragement and guidance for their children and supporting them to keep as many options open for their future. Many parents expressed the view that it was important that their children enter careers where they would be happy and find real meaning. The parents were in general agreement that future careers should enable their child to reach their potential and also to challenge them sufficiently in order to sustain their long-term interest.

Varied opinions were expressed when asked about any gender issues in STEM studies and careers with one parent commenting,

We've got three sons and I don't think I've ever thought about any of their careers as being gender specific. Having said that, if I had a daughter, ... I would want to think, I would like to give her more guidance around more career flexibility'.

another said:

If you can maintain your career while caring for a young family, how much better your career is. I really think with sons, it never occurred to me that there isn't a job that they can't do. I would have a different view having daughters.

and:

When he thinks of engineering, his father being an engineer in construction, yeah, he might think that is a manly job.

Contrasting parental comments included:

I think a lot of them don't consider that (gender issues) at all anymore, which I think is great.

and another added:

Oh, the teenage boys, I think they do. I don't think my son would ever consider something like nursing.

The majority of parents appreciated the career opportunity conversations available for their children and themselves through their schools, with one suggestion that this could be further enhanced with the introduction of a STEM Club. One parent was less confident about her own understanding of future careers added:

... there's always different things and I don't think we're well equipped to guide them through that. I've been going through things recently and trying to understand.

All parents agreed that studying related subjects at school was a sound strategy for future STEM careers. One parent commented:

We are meant to be preparing children to be 21st century learners. So, we've got to move with the times and technology is growing tenfold, STEM is something of the future.

Parents generally appreciated their children's exposure to inquiry, self-directed and cooperative learning at school and wanted them to move into challenging and meaningful STEM careers in the future.

Parents saw the STEM field offering future options with many pathways open for those with STEM backgrounds. Example comments were:

STEM is just the toolkit needed. Whether they lead to innovation and high tech or apps, if you haven't got the STEM stuff you can't move forward.

Yet, they also saw a need for additional career information resource. They suggested a need for innovative ways to introduce STEM connections such as work experience and, or internships, with career advisors available to guide students rather than simply ask what they would like to do in the future. Parents were concerned about the need for their children to be prepared for a flexible career and have the skills to adapt to changing demands in the workforce. One parent expressed concerns including:

There's going to be new careers that we don't have the skills for, and people that are over-skilled for careers that are dying.

while another reflected

I'm probably one of the last generations that will have a career with one employer for decades. You see young kids these days jumping not only between employers, but between job types.

and interestingly, another commented:

There is something of a dilemma there because you see lots of articles written about people moving away from the sciences and technology, yet at the same speed society is heading in that direction.

Discussion

It was evident that the student participants were actively engaging in career conversations with their parents and career counsellors during their middle schooling years. They were developing their self-efficacy and recognising the impact of course selections on STEM studies and future career options, as described by Schmidt et al. (2012). After coding, four major themes were identified across the interview data and these were titled as (1) influencing STEM career choices; (2) accessing STEM resources and support; (3) valuing STEM careers; and (4) envisioning future STEM careers.

1. Influencing STEM career choices

While students generally didn't recognise a deep understanding of contemporary STEM careers among their parents, they all appreciated strong parental interest, support and influence in their futures, along with an absence of pressure to follow parental careers, which is consistent with research by Middleton and Loughhead (1993), Rogers et al. (2018), Schmidt et al. (2012), van Tuijl and van der Molen (2016), and Zhang and Barnett (2015). In addition, 66% of students in this study intended to follow a STEM career as this matched their school strengths and interests, indicating these students are developing a sense of self-efficacy (Falco, 2017) and vocational identity (Rogers et al., 2018). Interestingly, several parents recognised strong STEM skill and aptitudes among their children due to those same traits being common among the extended family and modelled by various family members, described by Archer et al. (2013) as science capital, and also consistent with social cognitive career theory (Lent et al., 1994; Schmidt et al., 2012). Parents were aware that by engaging in close, constant conversations they were influential in the decisions made by their adolescent children.

2. Accessing STEM resources and support

Despite all career counsellors perceiving parents as the greatest influence on student STEM career choices they also recognised their own contribution in providing opportunities for student exposure to STEM careers and providing both parents and students with information. Participants in this study were provided with resources and information during incursions from guest speakers who presented STEM career details during career events, organised by career counsellors, for students and their parents alike. Such activities are consistent with social cognitive career theory and are likely to facilitate aligned understanding between students and their parents, in addition to increasingly meaningful conversations about future careers (Rogers et al., 2018; McCulloch, 2016).

Students also recognised and appreciated classroom teachers who spoke enthusiastically about STEM careers and integrated such information into their teaching subjects as

recommended by researchers Welde et al. (2016). According to researchers (Falco, 2017; van Tuijl & van der Molen, 2016; and Schmidt et al., 2012), by providing STEM career information focused on opportunities for adolescent students, career counsellors and classroom teachers were facilitating the development and strengthening of students' self-efficacy which encouraged their engagement in STEM studies.

3. Valuing STEM careers

Research findings by Watson (2016) suggested career counsellors were sometimes unaware of their potential bias and limited awareness of current STEM career trends; however, this was not evident in our study. While two of the three participants indicated they worked to assist all students, not only those interested in STEM careers, they were knowledgeable about the significance of STEM careers with each one proactively striving to keep abreast of new information in the field through engaging with mentors, STEM subscription lists, STEM professional development and, maintaining strong links with STEM industries. In keeping with the research of Falco (2017), career counsellors also recognised skills and characteristics such as: strength in maths, English, science; creativity, innovation, curiosity; and self-efficacy, independence and persistence as valuable attributes among students proposing to pursue STEM studies and careers.

With the exception of one, parents in this study indicated a strong desire for their children to transition into careers that followed their own interests and strengths, to ensure interesting and fulfilling work lives, and they all appreciated the opportunities a STEM career is likely to provide. Parents saw STEM careers as offering multiple options into the future, which in the view of Zhang and Barnett (2015) is important, as students achieve higher in science and maths when parents are perceived as encouraging of their choices. Recent research indicates that almost half of Australian students questioned, value highly STEM subjects at school and STEM careers (Australian Government, 2019).

Unexpectedly, there was minimal concern about the opportunities of embarking on STEM careers linked to gender. While some parents indicated their sons would not consider what were previously considered gender-based careers, students and other parents regarded future careers as open to either gender with perceived success in any career dependent on interest and ability. Missing from the data is any serious concern about the imbalance of males and females in STEM careers. This position contrasts with most of the literature devoted to career and gender studies (Falco, 2017; Australian Government, 2019; Lent, 2005; Garriott, Hultgren, & Frazier, 2017), where it is generally noted that interest in STEM subjects and careers while balanced in lower secondary school is higher among male students as students begin making STEM subject choices for upper secondary subjects and careers.

4. Envisioning STEM career futures

Counsellors explained that they would appreciate a greater STEM career focus in classrooms among science and maths teachers who they believed held the expertise. This position was also advocated by Welde et al. (2016) who encouraged the integration of

career education into other subjects to assist students connect with future careers and build self-awareness. Given that maths forms one of the pillars of STEM education and careers (Office of the Chief Scientist, 2013) it was unsurprising that one career counsellor expressed concern that mathematics is no longer a compulsory unit of study for upper secondary students in Western Australia. Archer et al. (2013), Falco (2017) and Watson (2016) strongly recommended that students be alerted to the significance of successfully completing the more challenging mathematics (and science) courses if intending to pursue a STEM career.

Linked to ideas of vocational identity were participants' concerns that students are now preparing for careers not in existence so they don't have the opportunity to engage in career awareness and development activities. As one parent commented, *'the jobs of tomorrow don't exist today, so how can you aspire to a job that doesn't exist?'*. While future career concerns are justified, recent research from Coelli and Borland (2019) may reduce some of these fears as they identified the source of major concerns stemming from one US paper published in 2013, which is currently under challenge.

Conclusions

On the basis of this study, answers are provided to our research questions.

1. How does the learning environment impact on students' STEM career interest and self-efficacy?

Students described their appreciation of face-to-face conversations with career counsellors and STEM guest presenters, in addition to conversations with enthusiastic, STEM-focused classroom teachers about their upper secondary subject selections and career aspirations. Through these conversations their skills and strengths were being affirmed as they continued developing self-efficacy. Students also described enjoyment in accessing online STEM career information, both in and out of the classroom. Surprisingly, students did not regard visits to Science Centres as especially relevant to their engagement in secondary school STEM subjects or to their future career choices. Those students and their parents, indicated their visits were memorable and enjoyable but occurred when much younger and long before career plans were being considered. This suggests that the benefits of providing students with vicarious experiences in STEM and opportunities to envision a STEM future identity for themselves, as recommended by researchers Archer et al. (2013), Australian Government (2019) Falco (2017) and Murcia and Pepper (2018), may depend on the timing and a focus being placed on youth engagement and interests in Science Centre experiences.

2. How do parents' attitudes to STEM and engagement with career advice resources influence students' STEM career interest and self-efficacy?

In this study, there were strong links between parents own STEM-based careers and the level of interest students expressed in undertaking STEM careers. All counsellors recognised the career influence parents introduce to their children, despite one indicating

that generally many parents do not always feel equipped to offer career advice. Parents in this study valued highly STEM careers, in addition to their engagement with career counsellors and the support they offered to students. Parents were also mindful of the significance of STEM studies to future career opportunities and perceived mastery of STEM skills as important for their children to succeed in the 21st century workplace.

3. How does career counsellor's awareness and engagement with STEM influence students' career interest and self-efficacy?

Career counsellors were very clear that their role was to support students across all career options including STEM. Nevertheless, career counsellors strived to familiarise themselves with career opportunities in STEM fields by keeping up to date with changes to STEM-related university courses, STEM careers and STEM-focused organisations. They demonstrated this familiarity and a willingness to assist students by organising visits and career opportunities with STEM industry representatives. In addition, they looked for STEM strengths among students and actively encouraged students to tackle the more challenging STEM subjects to enhance their future career options in this field. These proactive practices illustrated the value career counsellors place on future STEM studies and careers for students.

To conclude, this research was a small-scale study within three faith-based independent schools in Western Australia. The findings of the study are potentially limited to this context. It should be noted that the career counsellor role is not present in all independent schools in this state and is typically not included in government school staffing models. Furthermore, many of the parents interviewed in this study were employed in STEM fields and some participating students were in a school-based STEM trajectory program. Nevertheless, the indicative questions enabled informed and meaningful discussion among the groups during the interviews. The findings show the important role played by career advisors in not only supporting students but also parents with contemporary STEM careers information, as parents continue to be a significant influence in the career decisions made by young people. It emerged from the study that secondary school STEM subject teachers may have an increasingly important role in guiding students' career choices and as such this is an area worthy of further research.

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Appendix: Semi-structured interview questions

Student focus group

- Do you enjoy school? Why or why not?
- What are you good at or like at school?
- What hobbies are you interested in?
- What are your favourite subjects at school and what do you like about them?
- What careers are you interested in? Why?
- Have you considered a career in STEM (science, technology, engineering or mathematics)? Why? Why not?
- If you wanted to know about STEM careers where would you go for information?
- Are there any resources in the school that could help you?
- Are there any resources outside the school that could help you?
- Have you had any interactions with the school career advisor?
- Do you feel as though you have all the information you need to make a career decision?
- What are your favourite subjects at school?
- Is your family interested in STEM?
- Do your parents understand STEM?
- Are you influenced by your family in your choice of career?
- Do your parent's occupations influence your career decisions?
- What factors might influence your career choice?
- Do you have any special role models or 'heroes'?
- Do you feel school education is worthwhile?
- Would you like to study more STEM subjects in future?
- Do you think you are capable of having a career in a STEM area?
- Are you interested in more information about STEM careers?
- Is your gender a significant factor in your career decision making?
- Do any of your teachers embed career information in their lessons?
- What do you think has had the greatest influence on your career choices and or planning for a career?

Parent group

- What is it about your child that you think is special or unique?
- What type of careers do you think would suit your child? Why?
- What areas do you see as valuable career pathways for your child?
- Is your career advice influenced by your career?
- Do you feel your child has enough information to make an informed career decision?
- Does your child have clear career aspirations?
- Is your child male or female?
- Is gender a significant consideration in deciding on a career?
- Do you feel you have a significant role in assisting your child to make a career decision?
- What would you hope to be the main criteria for your child making a career decision?
- Do you feel that a career in a STEM area is a good foundation for your child's future?
- What information or resources would you want in your hand to support your child's choice of careers in STEM or generally?

Career guidance coordinator

- What is the basis of the career advice you give to students?
- What skills or abilities does a child need to go into a STEM career?
- What mechanisms exist to provide advice to students?
- Do you feel adequately resourced to provide advice on STEM careers and pathways?
- Do teachers integrate your expertise into class activities?
- Do you feel you know enough about STEM to provide advice in this area?
- Does your advice reflect STEM careers as a priority?
- Do you feel STEM careers have been prioritised recently?
- Do you have a major or supplementary role in influencing students' career decisions?
- How do you engage with external (from school) career guidance opportunities for students?
- What experiences, information, resources do you need to confidently provide advice on STEM career pathways?

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