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An exploratory study of the motivation of female leaders in professional Science, Technology, Engineering and Maths (STEM) careers

By

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Executive summary

Gender diversity in Science, Technology, Engineering and Maths (STEM) professions has been notoriously under-represented for many years. The gap is closing, but not fast enough to truly be representative of our gender split.

This study focussed on a small group of female professionals in STEM careers. Nineteen professionals were interviewed from nine companies in six sectors (Engineering, Technology, Geoscience, Environmental Science, Medical, Biomedical and Automotive). These were split into early career (less than 10 years' experience) and mid-career leaders (over 10 years' experience) in their respective fields.

The interviews focussed on their career evolution from the age of around 15/16 onwards to the present day and what influenced their decisions throughout this journey, whether this was people or incidents that occurred in their past. These also looked at what continues to excite and inspire them and will keep them in their professions.

The findings showed that there are numerous factors at play based on critical incidents and opportunities they were exposed to during their teens including role models, how engaging and practical their teachers were in STEM subjects and the support they received via family members or mentors. From this study, the findings suggest that as students move into their university phase there is a distinct lack of mentors but making use of peer groups is a large part of the support females use. As participants moved into early careers, financial burdens are often a factor in finding their first few roles, but as women move towards their mid careers, many have found a reliance on professional support networks, whether formal or informal, mentors and leaders they are exposed to as role models for their own leadership journey.

The findings will be disseminated to and education groups and schools as well as industries to look at what STEM leaders in schools could implement to improve the funnel of more females in STEM and what leaders and support networks could do to help retain female talent and nurture the next generation of STEM leaders.

There is a wealth of information available (Ashcraft et al, 2016; Davies, 2021; Glass et al, 2013) around the lack of females in STEM careers. Following on from personal experiences at

schools, my role as a female STEM leader and a parent of daughters, this subject fascinated me and an opportunity to dedicate some time to learning more about the situation and potential ways to improve the way for the next generation of female leaders.

I have been truly inspired by the stories I've heard about the routes people have taken, the obstacles they have overcome and the sheer tenacity and grit they endure daily in male dominated workforces whilst balancing their personal lives to work in professions they care about and make an impact in leadership roles.

Acknowledgements

I would like to thank my husband Steve for all his support while I added yet more stuff to my plate whilst completing this MA and my 3 daughters – Mia, Violet & Eva who inspire me to want to continue to learn, grow and hopefully enable their careers to be easier to navigate, and one day they might be inspired by me.

I would like to thank Zoe Cumberpatch for the reverse mentoring, help and advice she has provided throughout; Pamela Kitchen for the support at work and allowing me to experiment with different techniques with peers and co-workers; Harpreet Toor for supporting me in my efforts to bring STEM careers into Schools; my oldest school friends Rachel, Nikki and Lorraine for letting me ramble about my passions and ultimately decide on a dissertation topic.

Thanks to Women in Geoscience (EAGE) for the opportunity to present my topic and findings and encourage others to give back and inspire the next generation.

Thanks to the females who agreed to be interviewed and their engaging and inspiring stories.

Finally, Thanks to the Sunday Times for sponsoring my MA in Leadership.

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Chapter 1: Introduction

1.1 Females in STEM

Gender diversity in Science, Technology, Engineering and Maths (STEM) professions has been notoriously under-represented for many years. The gap is closing, but not fast enough to truly be representative of our gender split. Only 35% of students in STEM courses in higher education in the UK are women (UCAS data provided by HESA 2017/18), with computer science and engineering subjects as low as 19% female. This then drops down to around only 24% of women in the workforce (Davies, 2021).

There are many networks and organizations globally and in the UK (stemwomen.co.uk; stem.org; stem.org.uk; WISE; WiT) which aim to address this imbalance. In some subjects (physical sciences, such as chemistry and physics) the female proportion has increased significantly over the past few years due to various interventions and publicity.

There are numerous factors underlying the reason for gender imbalance in STEM subjects at university and careers subsequently held. These include societal gender stereotypes, cultural differences, lack of role models and self-belief based on society (González-Pérez et al, 2020; Thebaud and Doering, 2017; Bellou, 2011; Morgenroth 2015; Eagly and Wood, 2012)

1.2 Females in STEM Leadership

In the UK, figures show women account for only around one-fifth (21%) of roles on leadership teams (Sharma, 2020).

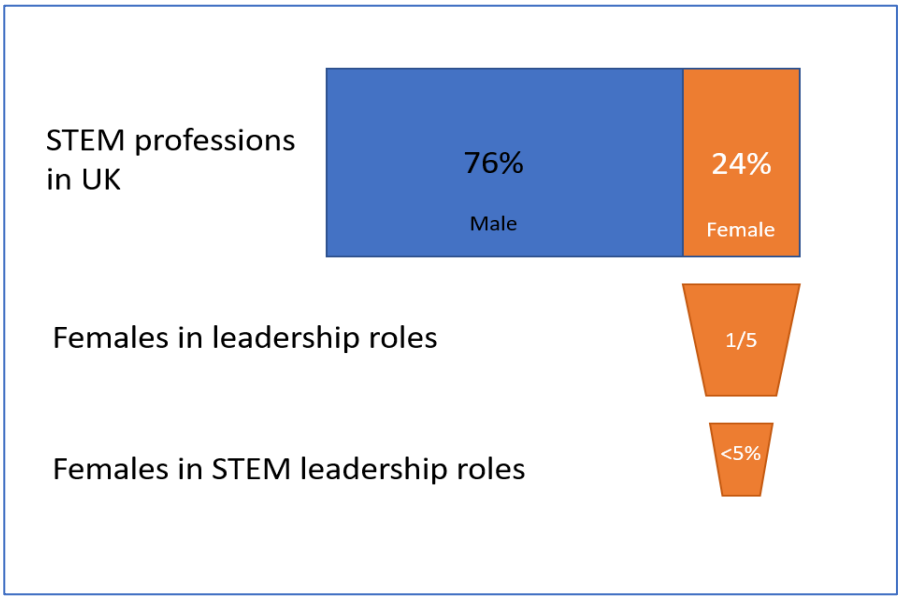
This means in our funnel (Illustrated in Figure 1.1) we are potentially only at one fifth of the 24% of women that go into STEM related leadership roles.

There are two ways we can increase the number of females in STEM leadership roles:

1. Increase number of females moving into STEM roles
2. Increase number of women in leadership roles.

This study will look at the motivation of both factors across key STEM professions and provide some insights in what we can do to increase the number of females in both areas.

Figure 1.1: Funnel of declining females in STEM leadership roles in the



1.3 Personal Objectives and Inspiration

There were several reasons that inspired my dissertation '**An exploratory study of the motivation of female leaders in professional Science, Technology, Engineering and Maths (STEM) careers**.'

Whilst developing my Personal Leadership Development Plan (Appendix 1) at the beginning of my MA in Leadership and subsequently during my Practice-Based Leadership Plan (PBLP) module I have had the opportunity to work more broadly in STEM opportunities, within schools and specifically working and encouraging young females. As a female geoscience software manager, I identify with both S (Science) & T (Technology) of STEM. My undergraduate and master's degrees are in Geosciences and I have been working in developing, deploying and supporting Geoscience software in major Oil and Gas companies globally for over 20 years. I have had the opportunity to work in numerous locations around the world with both Halliburton and Shell. As a parent to three daughters and working in a predominantly male dominated environment, becoming a leader and realising that I too was inspiration to young girls, this topic particularly resonated with me to explore in more depth during my dissertation. The idea evolved from a few critical incidents (Flanagan, 1954) in my own personal background and a specific incident as part of my personal leadership development module.

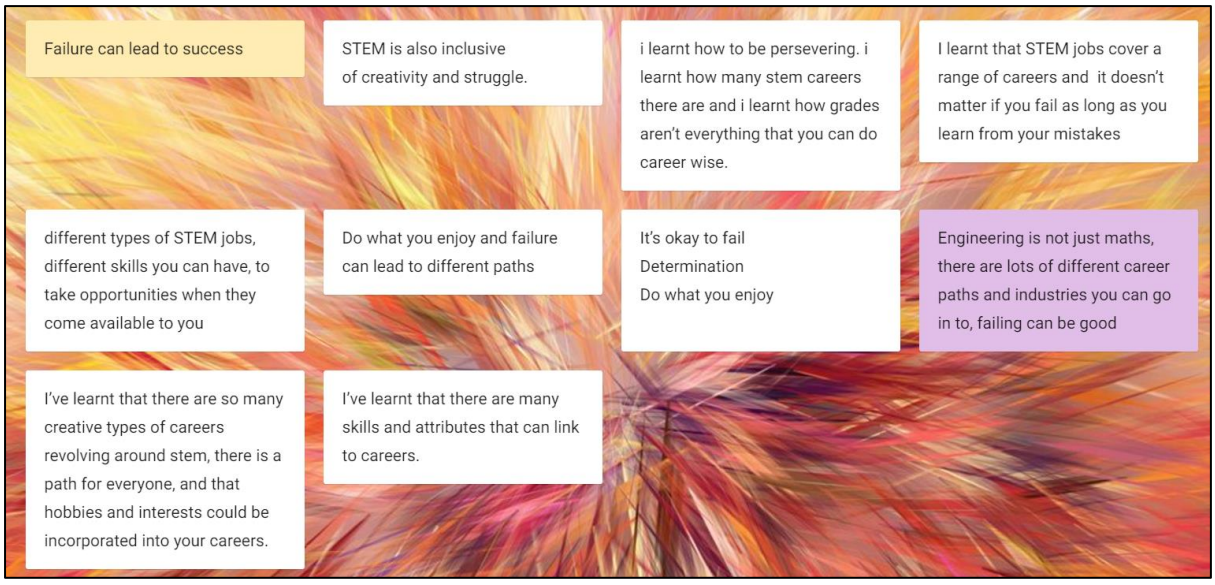
I had the opportunity to go into a girls' school and explain what my job entailed and subsequent discussed the gender pay gap and the relevance that would be for girls. I had brought my rock collections into junior schools and talked about geology to students, and while I found this personally fulfilling, I realised that children seem unaware of careers that stem from doing science at school. More recently I co-developed a STEM careers session for a large group of Year 8 girls prior to choosing GCSE options. Reflections from that event suggested that:

a) There were numerous myths and misconceptions of subjects they do at school and how they link to careers – no clear line of sight from academic subjects to careers.
b) Exposure to my personal career journey, I inspired them and was a role model. I was relatable and a parent to a student at the school and very accessible.

Figures 1.2 and 1.3 show photos and feedback from the event at Langley Grammar School.

Figure 1.2: Photo of Girls STEM careers session at Langley Grammar School (February 2020)

Figure 1.3: Excerpt from student feedback at Girls STEM Careers session at Langley Grammar School (February 2020)
Question: Describe three things you learnt from today's STEM session?



The subject and my personal desire to pursue this was connected and once I had undergone an Action Learning Set (Revans, 1998) activity and asked the question: '*What do I want to be known for?*' reinforced that I had a passion to make a difference and do something about it. I committed in my Personal Leadership Development Plan (Appendix 1) to focus on inspiring the next generation of female STEM leaders.

While working on this module I came across a Microsoft study of 11500 girls on Why Europe's girls aren't studying STEM. This research suggests that girls who have a strong role model between the ages of 11 and 16 are more likely to go into STEM careers (Microsoft, 2017; Owen, 2020).

This would be a great opportunity to see if this resonates along with other factors as to some of the rationale that there are fewer female leaders in STEM than male, both in early and even more so in later careers.

From my own experience, I particularly enjoyed some subjects at school and while no role models influenced me, the desire to do certain jobs that I was interested in initially (pilot and physiotherapy) were both grounded in science which I enjoyed. Ultimately, when deciding to pursue my eventual path in Geology was somewhat based on conversations with teachers at school and supervisors at university, some of which were positive and others the complete

opposite. This got me thinking that we see role models in different parts of life and know what is possible by others paving the way for us and knowing it is possible. These could be high-profile, or often people quite close to us that influence us in small amounts, a parent of someone, a friend opening doors by doing something first, or perhaps just a fascination or interest in something that you will do anything to continue that interest.

The other side of the study was based on my experience as a female leader and that there are still very few female leaders in STEM roles. I'd like to understand better with those that are in their mid-career, perhaps have returned after having children themselves, what motivated them to return to their industry and keeps them engaged in their field. Could this be the leaders around them? The Industry support and network they have? Mentors, role models and coaches or are there other factors at play.

1.4 Research Question and other Considerations

Other considerations were to focus on purely early career females, however, by expanding to Mid-career leaders, this would allow data to see if there is a trend within a company or industry and factors in females remaining in STEM professions.

Initial considerations were to focus solely on the impact of role models, this could be to consider the types and importance of role models that are required for females to be motivated towards a STEM career or other traditionally male dominated careers. These could be peers, teachers, managers, other leaders, hi-profile role models, senior directors, male's vs females and what are the attributes for a successful role model to influence future female leaders in male dominated professions (González-Pérez et al, 2020; Microsoft, 2017; Herrmann et al, 2016).

Ultimately the decision to focus solely on STEM was based on accessibility and convenience to participants and this is an area I am familiar with. The personal aspect was that this is something I am challenged with daily in a science and technology leadership role with very few female leaders in my organization and industry.

This was a good opportunity to explore further what has worked for today's STEM female leaders. Therefore, my research questions are:

RQ1: What and who has helped motivate female leaders through their career journey, from secondary education through to present day?

RQ2: What is still motivating females to stay in STEM leadership roles?

The sub questions will assess:

SQ1: What motivates and inspires females into STEM?

SQ2: What is uninspiring and demotivates females in (STEM) leadership?

The intent with the study is to be able to draw some key themes or conclusions that can be disseminated to the organizations and sectors from which the interviewees belong, such as: What kind of leadership and role models are inspiring them currently whether in the workplace, industry or elsewhere. This will be an opportunity to see across different STEM industries (albeit only a few) what similarities there are in the industries which keep female leaders engaged and motivated to stay in their industry.

1.5 Structure of the Report

Figure 1.4: Structure of the report

1. The introduction covers UK statistics regarding the numbers of females in STEM and leadership roles. I discuss my personal objectives and inspiration for the study and other considerations.
2. The literature review started by focusing on Role models, but then with more reading came a slight change in the study question to look broader at multiple reasons and rationale which motivated females to move into and remain in STEM and leadership roles. The literature review was iterative throughout the dissertation and still refining and reading today.
3. The methodology focusses on the approach and blueprint for the study including the purposive and snowball sampling (Bell et al 2019; Bryman, 1999) and critical incident techniques (Flanagan, 1954)
4. This chapter covers the interview responses and themes identified during different types of analysis. The individual participants are displayed in a Career-Evolution line. (A technique developed during the data analysis which will be discussed later)
5. This chapter discusses the findings and links the data with literature.
6. The conclusions and recommendations are a summary of the study with options to disseminate findings back to Education and Industry.
7. The Reflection covers both a reflection on the dissertation experience, Research questions, learnings and the complete MA Leadership programme.

Chapter 2: Literature Review

2.1 Introduction

The approach to the Literature review was that it initially drove and refined the research questions. Initially it focussed heavily on the impact of role models but following extensive research and considering the exposure to such rich data in the type of interviews planned, it made more sense to broaden the approach. This was done both regarding the subject areas, but also the breadth of materials researched. This included PhD theses, academic manuscripts, practitioner papers as well as journal articles and online organizations.

As this study focusses on females, it would be remiss not to discuss some perspectives on gender stereotypes (Eagly, 1989) and gender equality and how they play into the mix. This is a complex area and worthy of many other studies, this is a space that has changed over history and geography and is still changing today. The gender stereotypes, cultural backgrounds and equality will impact each person individually throughout the study so is a complex arena to summarise, therefore in the approach to visualizing the data and impact of people and decisions is personally derived.

2.2 Leadership and Gender

Leadership is an ambiguous and interpretive term which has evolved over the years. Northouse (2019) defines the term as being '*a process whereby an individual influences a group of individuals to achieve a common goal'* and therefore has the following components:

a. Leadership is a process
b. Leadership involves influence
c. Leadership occurs in groups
d. Leadership involves common goals

Academic research ignored issues related to gender and leadership until 1970s (Chemers, 1997), and more recent literature and networks incorporating LGBTQ+ (Lindsey & Hogue, 2015; lgbtleaders.co.uk) allows us to think broader in terms of our gender separation.

While I am aware of many definitions of leadership and breadth of gender polarity, for the purposes of this study I have focussed solely on female gender and individuals who have held a leadership role at some point based on the above definition.

> *'We still think of a powerful man as a born leader and a powerful woman as an anomaly'* (Margaret Atwood)

What if this is exacerbated by leading a dominantly male workforce such as those in STEM professions?

There are mixed opinions on styles of leadership which are dominantly female (Book, 2000; Rosener, 1995) and that there are thoughts that it can be either feminine or masculine, rather than a swath of styles for both genders. There are views which suggest that males and females lead in different manners, and that women lead in a more participative and more democratic way (Van Engen & Willemson, 2004) but what is probably more interesting to look at is what leadership styles are favoured by women irrespective of the gender of the leader. In Bellou's (2011) study she confirmed that men and women cannot be considered as uniform groups when examining leadership preferences, and Hoyt (2010) and Prime et al. (2009) say that men take charge and women take care. What if we need both these characteristics today especially leading through a pandemic?

Women in Technology leadership research illustrates that there is bias as to who gets chosen for leadership development programs or other development opportunities (Warren, 2009). Often this is done by senior leaders who are predominantly male, thus creating a self-fulfilling circle of same-ness.

2.3 Transformational Leadership

The process of inspiration is subjective to the follower, Transformational Leadership (Avolio, 1999) attempts to take into consideration the follower's perspective. What is also subjective to the follower is the expectation we have of our leaders.

With the intention to interview females and to explore what they found inspiring and motivational in people, whether leaders, peers, role models or mentors, it is critical to understand the follower's perspective, not just that of the leader.

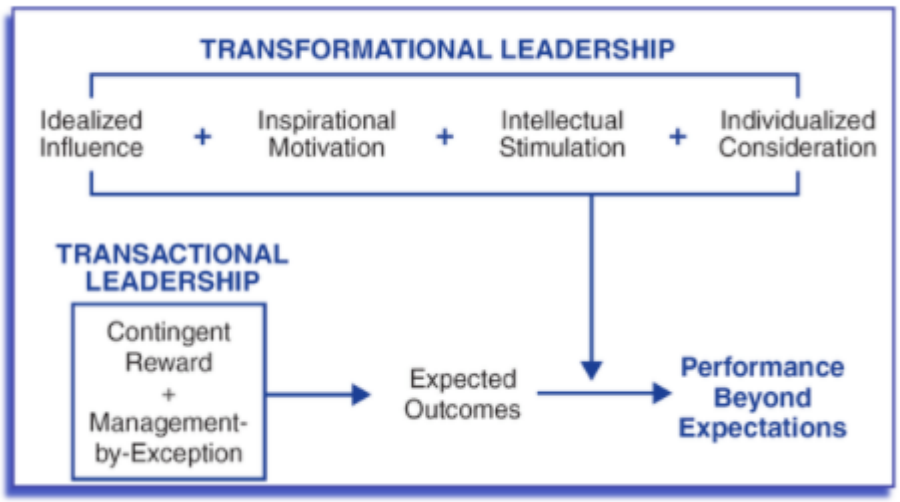
Bellou (2011) suggested that females and males may have different expectations of their leaders and their role and purpose and as such her study was based on the following hypotheses:

'H1a: Women followers are more likely to expect their leader to be people and change orientated.

H1b: Men followers are more likely to expect their leader to be task orientated'

This is synonymous with the perception that women favour Transformational Leadership. This framework and the factors involved (Avolio, 1999) is concerned with '*improving the performance and developing followers to their full potential'*. They are effective at motivating staff and concerned for the greater good rather than a personal interest or self interest

Figure 2.1: Transformational Leadership Avolio (1999)



This is known as the Four I's

- **Idealized Influence** – this is the emotional part and describe leaders who act as strong role models for followers; followers identify with these leaders and want to emulate them.
- **Inspirational Motivation** – this is descriptive of leaders who communicate high expectations to followers, inspiring them through motivation to be part of the shared vision of the organization

- **Intellectual Stimulation** – this encourages creativity and innovation and to challenge their own beliefs as well as the leader and organization
- **Individualized Consideration** – this encourages individuality within the team and that not everyone responds the same. Coaching is critical

What does this mean for the follower?

If leadership involves influence, then it is about the relationship, communication and interaction the leader has with its followers (Ruben & Gigliotti, 2017). The Idealized influence factor comprises two components, one part based on the attributes of the leader based on the follower's perceptions and the follower's observations of the leader - an attributional component and behavioural component. This means at its most positive, as a role model and leader, followers want to follow and exemplify their leader.

The leader inspires them to be part of a team and part of the vision and solution and their role in the future of the organization.

The leader gives the followers the environment, space and encouragement to challenge the status quo and be creative and innovative in solving problems.

By listening and responding to individual needs of staff, followers feel cared for, trusted and empowered.

Ultimately Transformational Leadership (Avolio et al, 1999) will encourage and motivate staff to accomplish more than is expected in a task or role, which for the greater good of the team or organization.

While Transformational Leadership (Avolio et al, 1999) seems inherently positive, personable and nurturing, there are circumstances where the individualistic approach may not and will not work. Perhaps with factory or time/cost sensitive and speed is of the essence. Specifically thinking about females and highly technical professional careers, this can be appealing when working in large and looking at leaders for characteristics that you feel wanted and heard in a role or organization.

2.4 Impact of Role Models

A role model is defined as a person whose behaviour, example, or success is or can be emulated by others, especially younger people. Someone who is worthy of imitation.

By having role models accessible to female adolescents in STEM professions and especially leadership roles, we could potentially impact the number of females ending up in STEM leadership roles. Young girls will look at potential careers and see that it is possible and be inspired, perhaps wanting to emulate that job, or experience. It might not be purely based on the science but seeing a job means you need to collaborate across global boundaries, is flexible to your needs, or make an impact using some new technology or idea could all be ways in which a role model influences someone else.

Having a role model does not stop at adolescence and that in the workplace we look towards leaders either in our own organizations, through our professional support networks and peers. These might not be coined as role models but could be considered more a leader-follower relationship that you learn from – potentially synonymous with Idealized Influence factor from Transformational leadership (Avolio et al, 1999) in section 2.4.

Microsoft (2017) claims 'The major drivers impacting girls' interest in STEM subjects. These include **encouragement** and **mentorship**; gaining **practical experience**; and having **visible role** models.'

The Microsoft (2017) study suggests that it is the lack of role models which channels girls away from STEM careers, and their recommendation is

> '*Having visible female role models sparks girls' interest in STEM careers and helps them to picture themselves pursuing these fields'.*

The study doesn't elaborate on what that could look like or how, or what exactly a role model is defined as. This study is an opportunity to gain further insights in this area and Morgenroth (2015) does further investigate this.

González-Pérez et al (2020) did an intervention study to look at if there was an intervention in a school environment where females role models are brought into schools to discuss their

career. This is a similar intervention that I had done previously at a school in Berkshire, where realising that I was a role model. The findings were that an intervention,

> '*improves girls' beliefs that they can be successful in STEM fields and increases their likelihood of choosing a STEM career' (*González-Pérez et al, 2020).

These sessions were completed by accessible role models and volunteers and weren't high-profile yet made a positive impact in the belief and expectation of success in further STEM decisions.

In a 1999 US study (Nixon & Robinson, 1999) looked at the effect of female faculty members as role models for female students. While this study is old and not specific to STEM subjects, it highlights that there is only a small amount of increased academic attainment purely based on this factor, but that other foundational factors also have a bearing on female student achievement such as personal and family backgrounds. They cite that what is more convincing is the mentoring of female students by female faculty staff.

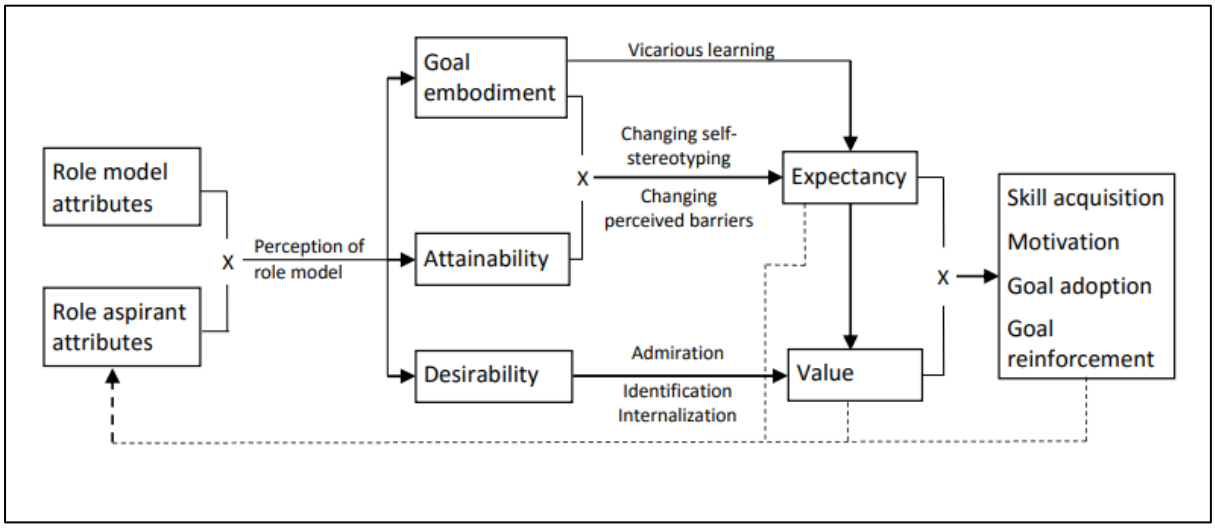
Schier (2020) investigated how role models affect the competitiveness of males and females, and results suggest that women's confidence increases about their own ability after observing a female role model.

Morgenroth (2015) delves into more detail to understand specifically how a role affects motivation and goals and the effectiveness of role models. In her thesis, she dedicates an entire chapter to looking at role models and science, but also develops a simple framework The Motivational Theory of Role Modelling (MTRM), to attempt to provide consistency in the way role models are defined and used and 'role modelled'. This also includes the role of the recipient of the role model and their perception (the role-aspirant). This is synonymous with Idealized Influence from transformational leadership (Avolio et al, 1999) as it considers the attributes of the leader based on the perception of the follower (role-aspirant). Figure 2.2 depicts Morgenroth's MTRM.

This framework considers that the role models are:

1. Acting as behavioural models
2. Representing the possible
3. Being inspirational.

Figure 2.2: Morgenroth (2015) Motivational Theory of Role Modelling



What is clear is from the wealth of studies already available and the lack of progress of both women in STEM numbers increasing as well as female STEM leaders, it is more than just role models which influence and motivate women to move into and remain in STEM roles and become the future leaders.

2.5 Role of Mentors

The term mentor goes back to ancient Greece and was even then someone who was a 'trusted tutor', and while there are evolving definitions (Haggard et al, 2011) and similarities and differences to the term coaching, the characteristics of mentoring defined by Passmore (2007) in figure 2.3 will be used in this study.

Figure 2.3: Mentoring Expectations. Adapted from Passmore (2007)

	Mentoring
1. Level of formality	**Less formal:** agreement, most typically between two parties
2. Length of contract	**Longer term:** typically unspecified number of meetings with relationships often running over 3–5 years
3. Focus	**More career-focused:** typically a concern with longer-term career issues, obtaining the right experience and longer-term thinking
4. Level of sector knowledge	**More sector knowledge:** typically mentors have knowledge of organisation or business sector
5. Training	**More management training:** typically mentors have a background in senior management
6. Focus	**Single focus:** more typically a single focus on the needs of the individual

In mentoring there is a relationship between the mentor and mentee which is different from a role model – where there may be no relationship at all, just characteristics that a person resonates with or that appeals to them sufficient to want to emulate them or those characteristics. The specifics of the relationship are often contracted up front to understand what each is expecting from the relationship. While the definition might change as to the specific roles and expectations of a mentor (Haggard et al, 2011), what is important is the output or impact that a mentor has on a person and the positive role they can play.

Scandura & Williams (2001) defines mentoring as:

> '*a one to one relationship between a more experienced and senior person (Mentor) and a new entrant or less experienced person <mentee>… A mentor can generally be defined as an influential individual in your work environment who has advanced work experience and knowledge and who is committed to providing upward mobility and support to your career*.'

Day & Allen (2004) describe it as someone who:

> '*serves as a role model, provides support, direction and feedback regarding career plans and interpersonal development*.'

Seibert (1999) describes it as:

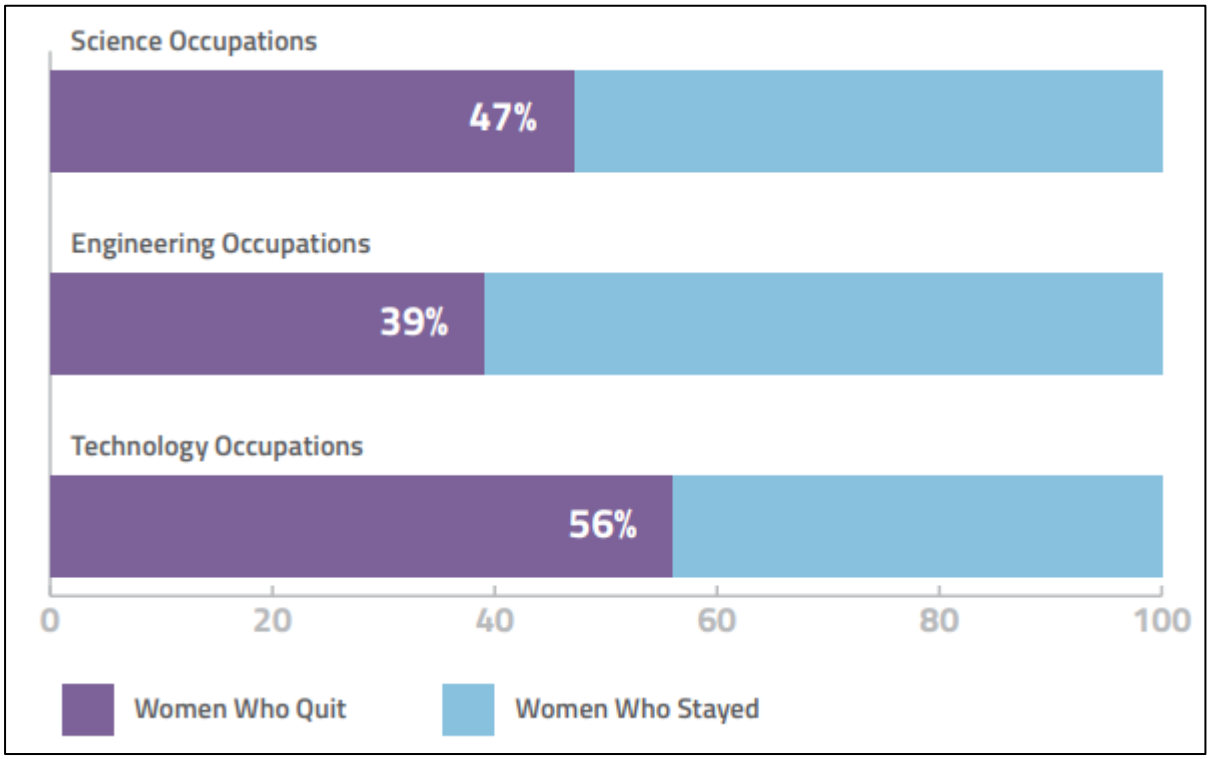
> '*Someone, other than your manager or immediate co-workers, who provides you with technical or career advice, coaching, or information on an informal basis.*"

All of these suggest a relationship whereby there is an element of seniority and experience that can help nurture or coach them in making better decisions for themselves. What is not clear is the definition when an individual will confirm that they have had a mentor, as everyone has their own perspectives on what that means. Others may call that role a coach – this is generally is more formal, can be industry agnostic with specific skills in asking questions to help the coachee through a situation (Van Nieuwerburgh, 2017). It is possible that mentors use coaching skills (such as listening and questioning techniques) whilst working with their mentees, but equally could be advisors.

2.6 Females Remaining in STEM Careers

Female retention or persistence is a challenge in STEM professions, the Microsoft (2017) study says, *'once in a STEM career, girls are more likely to leave and many of them do not return.'* Attrition rates for females in STEM are around 50% (Hewlett et al, 2008) at mid-level points (10-20 years)

Figure 2.4: Female attrition rate across Science, Technology and Engineering (Adapted from Hewlett et al, 2008, cited in Ashcraft et al, 2016)



Glass et al (2013) shows that around 50% of females leave STEM roles over their tenure compared to only about 20% of women in non-STEM fields. Attrition rate for females across the board is likely to be as a result of competing work-life balance challenges, but also Glass (2013) found that exiting the workforce completely was rare. The Hewlett et al (2008) innovation centre study found that around half continued in technical areas just moved companies, and half went into non-STEM related fields such as. It seems the females are not staying to become the future STEM leaders but may still be in the workforce and leaders. Why do females not persist in STEM fields?

Workplace experiences such as lack of support for work-life balance challenges, undermining behaviours and lack of support from manager or leaders, including less opportunities for training and development were cited as impacting the decision to leave their field (Fouad et al, 2012). Women are reported their career prospects as being poor - A Glassdoor survey from 2014 suggests women in technology feel more dissatisfied than men in their careers and that (Hewlett et al, 2008) report that about 32% of women feel they are 'stuck' or their career has stalled. If they feel dissatisfied, don't feel cared for, or a sense of belonging in their role or

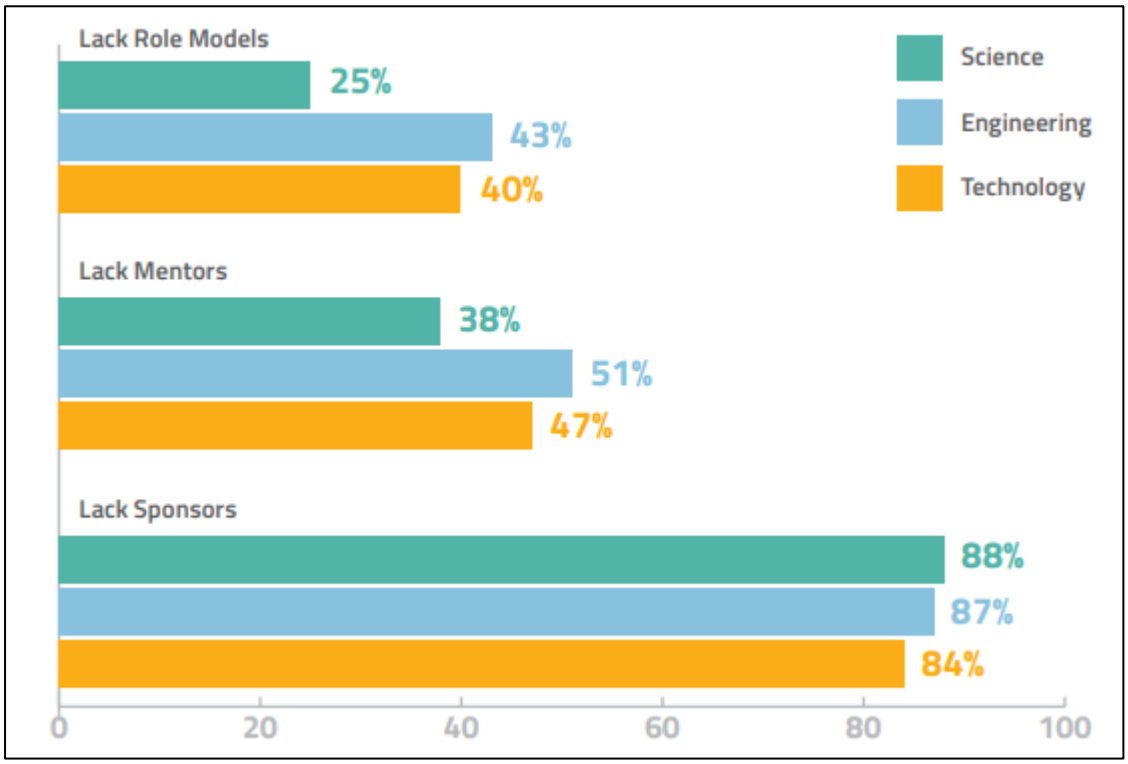
organization then it makes sense to look elsewhere, perhaps using transferrable skills and moving away from the STEM field.

Hermann et al (2016) reviewed (Barbercheck, 2001; Cheryan & Plaut, 2010; Schmader et al, 2008; Steele, 1997)) and concluded that women are:

> '*more likely to leave science, technology, engineering, and mathematics compared to men, in part because they lack similar role models such as peers, teaching assistants, and instructors… female role models are more effective at retaining female students'*

If there were more female leaders and role models in the STEM professions would that encourage more to stay? Hewlett et al (2008) also cites that lack of mentors, role models and sponsorship make them feel more isolated and reduces sense of belonging. See figure 2.5. This aligns with Welsh McNulty (2018), who recognises the importance of women supporting each other in the workplace and Ibarra (2019) who recognises that sponsorship at the senior level is lacking.

Figure 2.5: Lack of role models, mentors and sponsorship in Science Engineering and Technology.
(Adapted from Hewlett et al, 2008, cited in Ashcraft et al, 2016)



2.7 Research Questions and Process

The literature around qualitative research for this study was primarily from Bell et al, 2019) including insights into data sampling methods of purposive sampling and snowballing method (Bell et al, 2019; Bryman, 1999) were used and traditional hand transcribed field notes (Bell et al, 2019). The method selected for interviews and experience was synonymous with feminist research (Bell et al 2015) which advocates a framework which establishes:

- High level of rapport between interviewer and interviewee
- High degree of reciprocity on the part of the interviewer
- Perspective of women being interviewed
- Non-hierarchical relationship

The data from interviews had thematic analysis (Ryan & Bernard, 2003) done and in parts narrative analysis (Mishler, 1986) and life history research (Plummer, 2001) was considered. Miles (1979) described qualitative data analysis an 'attractive nuisance and as such some new techniques (Career-Evolution Lines) were developed to interpret the data collected.

2.8 Summary

Several papers focus on a single theme as to its influence on a female going into STEM careers and leadership roles such as role models (González-Pérez et al, 2020; Nixon & Robinson, 1999; Schier, 2020) and mentors (Microsoft, 2017; Welsh McNulty, 2018) and some look at the persistence of females in STEM careers (Hewlett et al 2008; Glass et al, 2013; Hermann et al, 2016). There are a several factors regarding the influencing of females into STEM professions including foundational factors such as gender bias and stereotypes and then the importance of role models and mentors for females to persist in STEM professions. In the next section I will discuss how these themes will factor into the interviews with existing early career STEM professionals and those who are have persisted in their STEM careers.

Chapter 3. Methodology

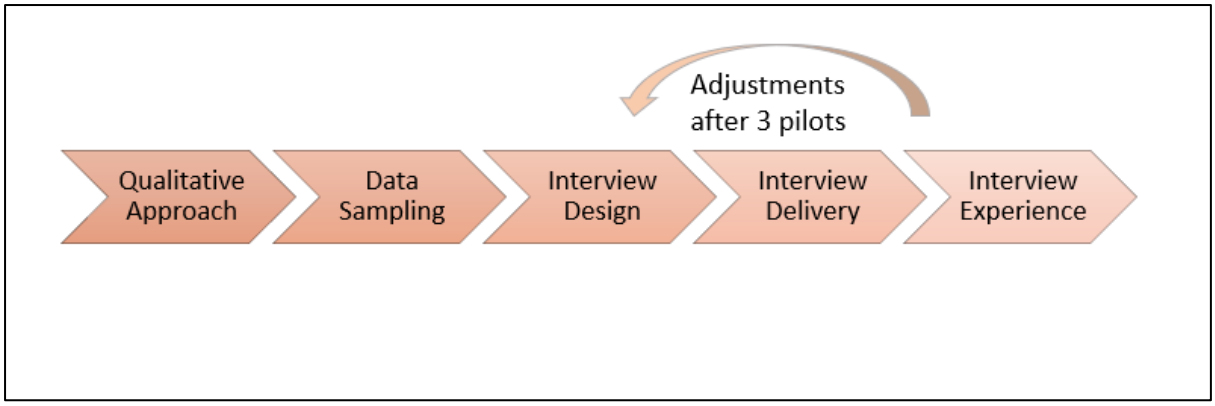
3.1 Introduction to the Methodology

The key steps in figure 3.1 were taken to be able to answer the research questions:

RQ1: What and who has helped motivate female leaders through their career journey, from secondary education through to present day?

RQ2: What is still motivating females to stay in STEM leadership roles?

Figure 3.1: Methodology approach and key steps



3.2 Qualitative Methodology

This was an opportunity to look at a group of females who are in STEM careers, who have committed to a professional career in a STEM related profession and fulfil a leadership role. To be able to explore deeper each participant's rich yet holistic background of motivations to understand what took them on that journey, it was critical that the approach was to have a small select group that would be keen to share their personal past experiences and today to understand what it is that motivates females to undertake STEM professions and remain in them.

In order to understand which people (role models, teachers, managers, leaders) had an influence on their decisions or critical incidents (Flanagan, 1954) that happened had an impact on decisions made by an individual to follow a STEM career it was required to focus on a small group of people that rich data could be elicited through interviews.

To enable the career journey or evolution of the participants to be captured, it was important to anchor the data collection at a definite point in all their histories. At schools in the UK, students start narrowing their academic subjects at age 14 for GCSE then again at 16 for A-levels. This is a pivotal point where decisions on their future need to be made. The rationale to select 15-16 years old as the anchor point was based in this and they had already made some decisions based on their educational route by deciding which GCSE's to pursue. They are then in a critical decision-making time before they go to a 6th from college, take A-levels, or possibly think of careers and decide on subjects to fulfil those careers. In other countries similar narrowing takes place and this study includes participants educated overseas and the results could be applicable globally.

The structure of the interviews was for the participants to, 'take themselves back to their 15-16-year-old self' and start telling their career journey story up to the present day and this would enable probing questions in the interviews as to why they made certain decisions.

3.3 Data Sampling

In order to investigate the motivations of females in STEM, candidates needed to be female and in a STEM profession. A variety of STEM professions was selected to ensure there was more than one interview per profession and company. This initially started as generic purposive sampling (Bell et al 2019) and was based on key criteria such as STEM field, company, sector and years' experience, but also necessitated snowball sampling (Bryman, 1999) to reach others. Fifteen interviews were planned, but snowballing offered more interviews that were unable to be completed due to time constraints and six were regretted.

To enable me to connect with people in multiple professions, LinkedIn was used to make some initial connections and many of the others came via the snowball effect. This was especially helpful to collect data from more than one person in each company. During this study, specific companies will not be mentioned, but in most cases, there were 2-3 candidates in each company that took part, except for Academia where this was generic. Where there were 2-3 candidates from a single company it was intended to have both early (0-10 years' experience) and mid-career (10+ years' experience) representation to look at the evolution in a company/profession.

3.4 Interview Design, Structure and Questions

To enable consistency across the participants specific demographic data was requested, such as name, age and experience bracket, A-levels taken, and university degree(s) achieved including a brief career summary. There was a high-level set of questions which was used to structure the interview (see figure 3.2)

The intention was to spend half of (30 minutes) the allotted time (one hour) looking back into their education and motivations for choosing their STEM path to answer how to:

1. Increase number of females moving into STEM roles

The second half would be either discussing their present-day leadership experiences and how to:

2. Increase number of women in leadership roles

All participants were emailed the high-level questions (Figure 3.1) ahead of the interview, and ethics and data privacy details (Appendix 3).

Figure 3.2: Semi Structured High-level Questions to all participants

Demographic Questions answered via email after first 3 interviews.

- Name
- Age bracket
- Experience bracket
- Schools, types/names
- A-level subjects
- University(s) and course(s)
- Career to date information

Part 1: Looking Back - Your education experience and leadership exposure

Educational experiences: 25m

- What inspired you to pursue a career in …….
- What did you find inspiring at school? Who? What? Why
  (Role models, critical incident)

- What leadership experiences you exposed to at school/Uni age? Self/Others
- What influenced you considering further education in STEM?

Part 2: Current and looking forward – What maintains your motivation to remain in your profession

Professional experiences: 25 m

- What influenced your decision to move to the organizations you did? Who, What, Why?
(Role models, critical incidents)

- What professional networks/support are you involved in?
- What will make you stay in the sector?
- What and who inspires you in the leadership you see today? Why?
- What would you say to your 15yr old self based on your experiences?

Feedback: 5 mins

3.5 Interview Delivery and Questioning

All participants in the study have been leaders or have had some leadership experience. They self-selected which elements of STEM they most closely associated with and selected their experience bracket within their field. Table 3.1 shows all interview participants and the criteria defined and a coding system which will be used throughout the study.

Table 3.1 Data sampling and coding of Interview Participants

code	STEM	early/mid	experience	sector	educated	school	current role
T1	T	early	0-5	technology	mix	state	IT Business Analyst for Major Technology co.
T2	T	early	0-5	technology	mix	state	Consultant at Major Telecommunications co.
T3	T	early	0-5	technology	mix	state	Business Analyst Test Consultant at Telecomms co.
SE1	SE	early	0-5	engineering	mix	private	Structural Engineer
SE2	SE	early	0-5	engineering	mix	state	Geotechnical Engineer
SE3	SE	early	0-5	biomedical	mix	private	Masters Student
S1	S	early	0-5	geoscience	mix	state	Exploration Geoscientist at major energy co.
EM	EM	early	0-5	aeronautical	mix	state	Fleet Maintenance at UK Airport
S2	S	early	0-5	geoscience	mix	state	PhD student > Grad Geoscientist at major Energy co.
T4	T	early	5-10	automotive	mix	state	Strategy and Planning in Major Auto company
S3	S	early	5-10	env science	mix	state	Senior climate science advisor
T5	T	mid	10-15	technology	single	private	Digital Planning and Delivery in telecomms.
STE	STE	mid	10-15	biomedical	single	private	Infectious Disease Manager
S4	S	mid	10-15	medical	single	state	General Practitioner
S5	S	mid	15-20	medical	mix	state	Speech and Language therapist
S6	S	mid	20+	medical	mix	state	Locum in General and Private practice
S7	S	mid	20+	technology	mix	state	Managing Consultant at major technology co.
S8	S	mid	20+	geoscience	single	private	Exploration Manager in major energy co.
M	M	mid	20+	automotive	mix	state	National Training Manager for major auto co.

Some simple analysis of the demographic data shows that of the 19 participants:

- 7 were educated outside the UK
- 3 did arts subjects at school/university
- 15 attended mixed sex schools, 4 at single sex schools
- 14 attended state schools, 5 at private schools

Tertiary education:

- 5 to BA/BSc level
- 8 to MA/MSc level
- 6 to PhD/Doctor level
- 1 had no Undergraduate degree but completed an MA

I had a personal connection with four mid-career participants and one early career participants, I did not know any of their career histories or their motivations for moving into the professions they pursued.

3.6 Feedback and Adjustments

Following 3 pilot interviews whereby demographic data was collected during the interviews, it was noticeable that this was derailing the flow of the interview as the conversation sometimes got stuck on the brief career summary. Moving forward the demographic data was requested upfront via email, this gave a better interview starting point as there was some key information to start the conversation with and the flow of the interviews improved. The data from the three pilot interviews remains in the study as the questions and content did not change, only the ordering and process.

The following feedback and recommendations were given on the interview format and experience:

1. Ask participants if they have read the questions ahead. (While this is good practice, was a good insight as many had not and was helpful to understand the starting point.)

2. Be clear about the structure of the interview up front and that the high-level questions will be covered, but additional probing will be required in certain areas.

   Following this recommendation, the following analogy was used to set the scene:

   'This is an 'exploratory' study, and with exploration, we don't always know what we are looking for unless we get a lead. When I get that lead in something you say, I will probe further and hopefully we will find a nugget, or some gold.'

3. Explain that it is anonymous, and the use of names is easier for note taking rather than supervisor of X or manager at Y. It was very challenging in the early interviews to keep track of which people did what and led to confusion in the interviews and note taking. Note taking needed to be clear and vivid, so this reduced confusion (Bell et al, 2019).

3.7 Field Notes and Data Recording

Open-ended questions were important to enable the participants to tell their story and not lead them into a specific direction. These Semi-structured interviews were conducted virtually with video on (where possible) and recorded. Some of the recordings have been re-watched to investigate the interview technique and ensure that questions were not leading participants down a path. During each interview lengthy hand-written notes were transcribed throughout; the recording and automatic transcription was available for back up and to use to capture or record quotes. As an experienced hire interviewer, capturing notes whilst interviewing was a skill, I was already versed in.

There were some circumstances when advice was sought by the participants and an opportunity arose for mentoring in the session. This was an indication that the participants felt comfortable in the interview and relationship, it was necessary to switch out of 'interviewer mode', respond to the question and recommend further discussion after the interview.

Participants were asked at the end of the interviews how the experience felt for them whilst also recording my own feelings and observations on the interview and annotating notes.

3.8 Summary

The 19 Participants were selected initially via LinkedIn and then further snowballing (Bryman, 1999) to complete the cohort and demographic across sectors. Email invites with expectations of the interviews including ethics and data privacy were collected prior to scheduling. The interviews took approximately an hour done virtually on MS Teams and recorded. Extensive field notes (Bell et al, 2019) were taken during the sessions and annotated afterwards with in the moment observations and notes on how the sessions went. I will discuss further how the data was analysed and themes in the next chapter.

Chapter 4: Data Analysis

4.1 Introduction and Approach

The interviews were semi structured and based on the two original research questions, the intent was to look for themes which stood out for what motivates women. Initial thematic analysis (Ryan & Bernard, 2003) was done throughout the interview period and post interviews as they were collated and analysed from transcribed notes, initial key insights and reflection from interviews and later visually.

This study looked at the evolution of their career to the present day, and as such part of the challenge was to consider ways to interpret and visualise such a broad and deep amount of data in a simple way which could be used to narrate the story of the participants careers and/or pull out key themes.

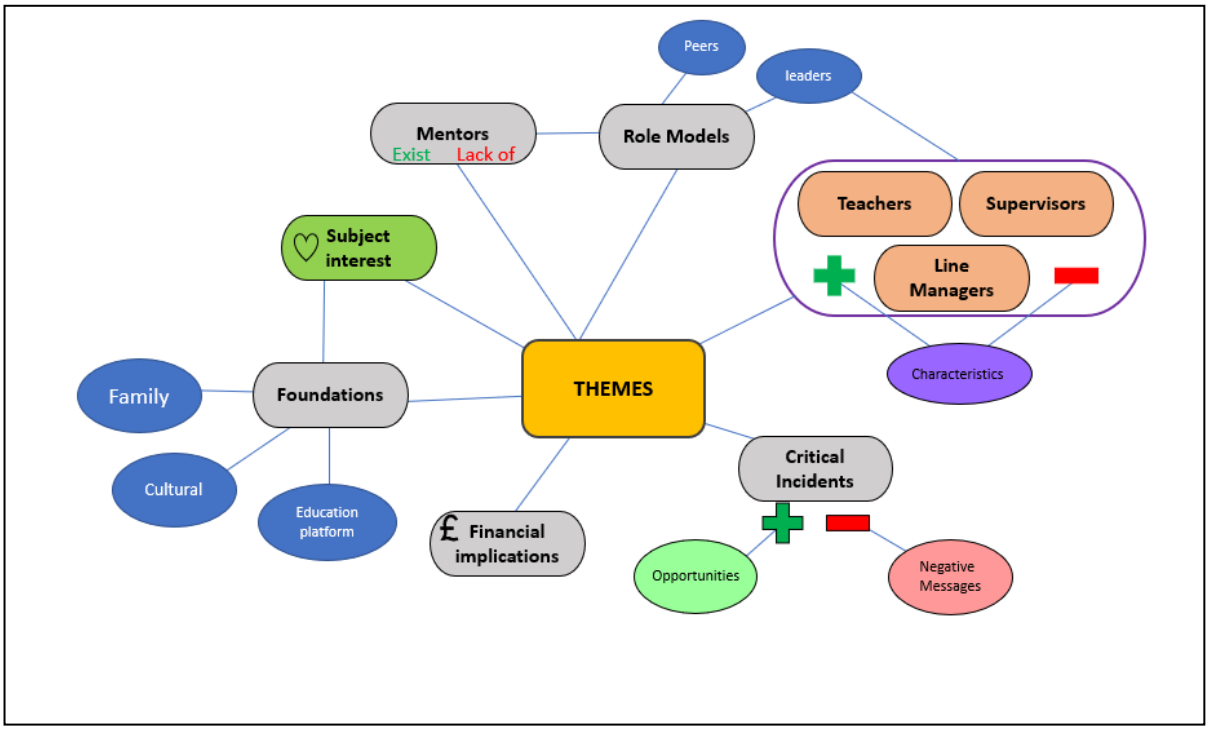
The questions which were considered:

1. What do the participants have in common?
2. What is lacking or missing?
3. How could this data be interpreted?

4.2 Thematic Analysis

A simple Mind Map in figure 4.1 shows the key themes identified during and post interviews with participants. This thematic analysis (Ryan & Bernard, 2003) became the key components and building blocks for a display of each participants Career-Evolution line. This method of displaying a single participants career along an evolutionary line was created following a discussion with my supervisor and some early feedback from peers before investing heavily in the process to generate one for each interview participant and their data. Miles (1979) described this qualitative data analysis an 'attractive nuisance'. In an attempt to make this rich data feel more attractive I developed a mechanism to attempt to visualise each person's story; while it feels like the rich interview content is lost in a single line, it does help identify similarities and differences across the participants. The individual Career-Evolution lines are visualised in figures 4.2.i – vi.

Figure 4.1: Thematic analysis displayed as Mind Map



4.3: Career-Evolution Lines

Figures 4.2.i - vi shows the Career-Evolution lines key followed by the 19 individual participants.

Figure 4.2i: Career-Evolution lines key

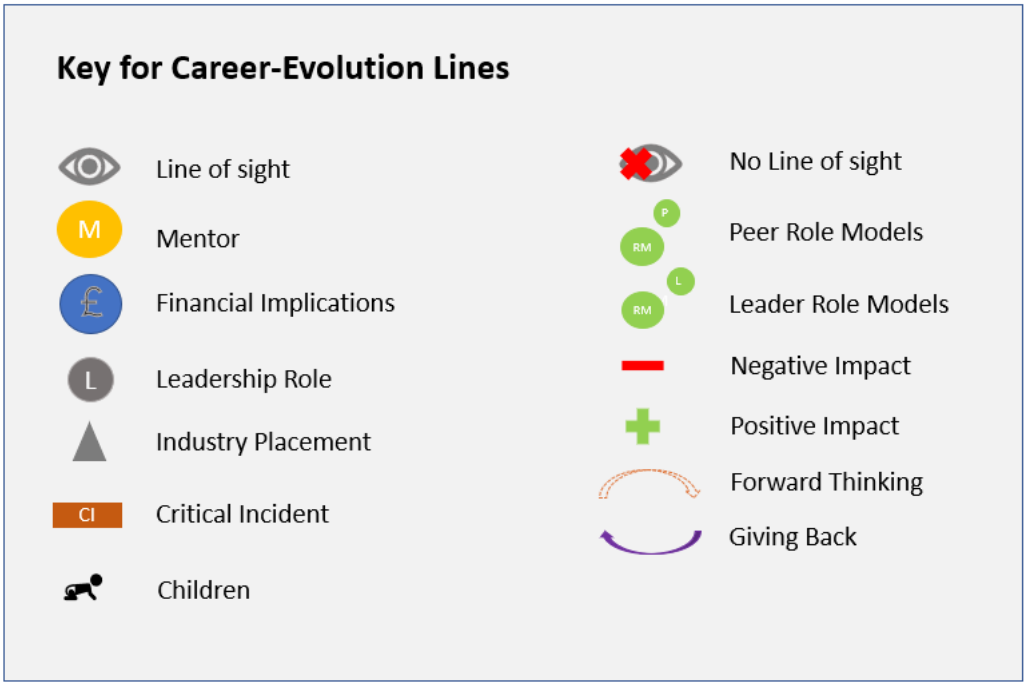
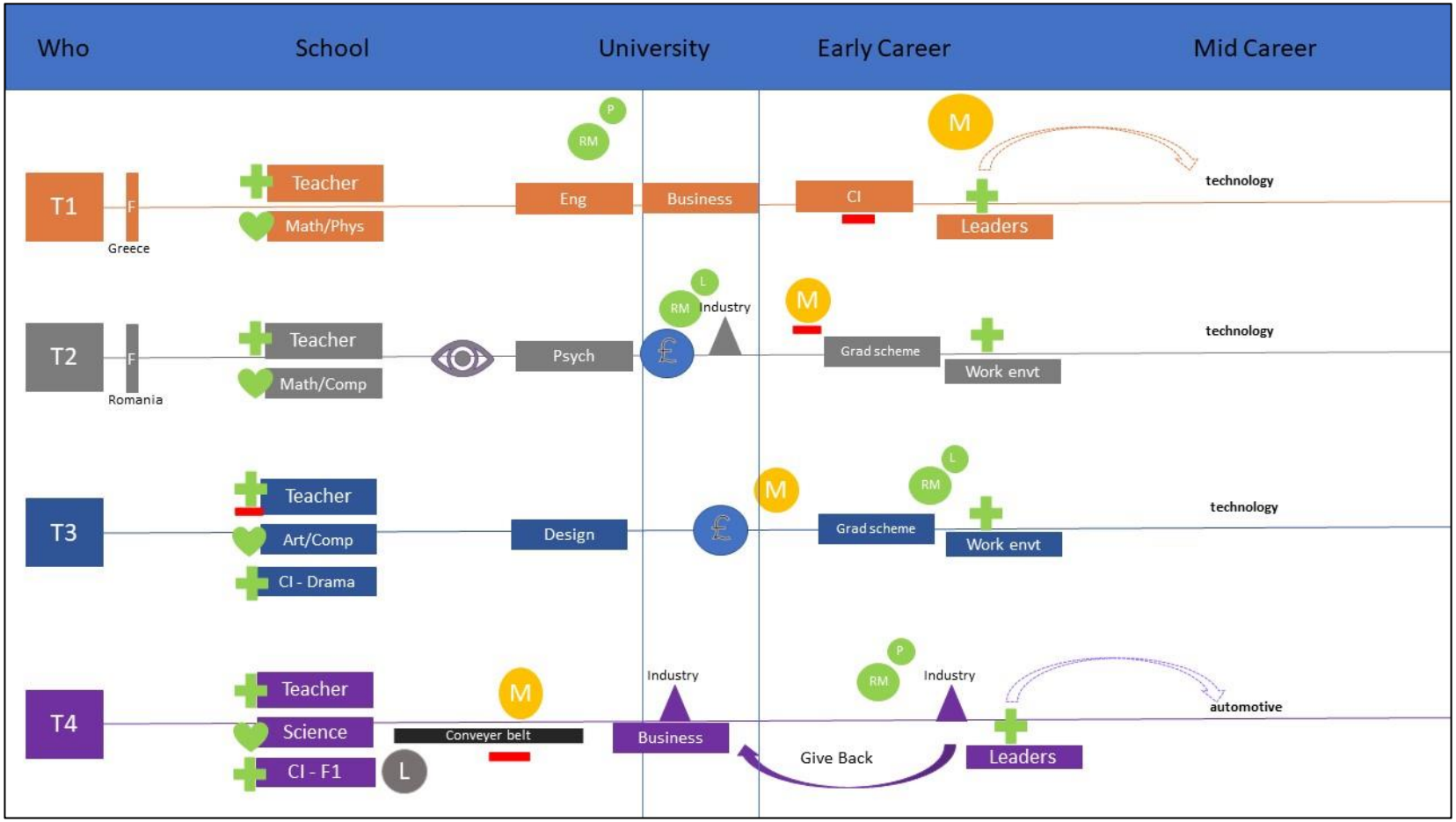


Figure 4.2ii: Participants 1-4 Career-Evolution lines



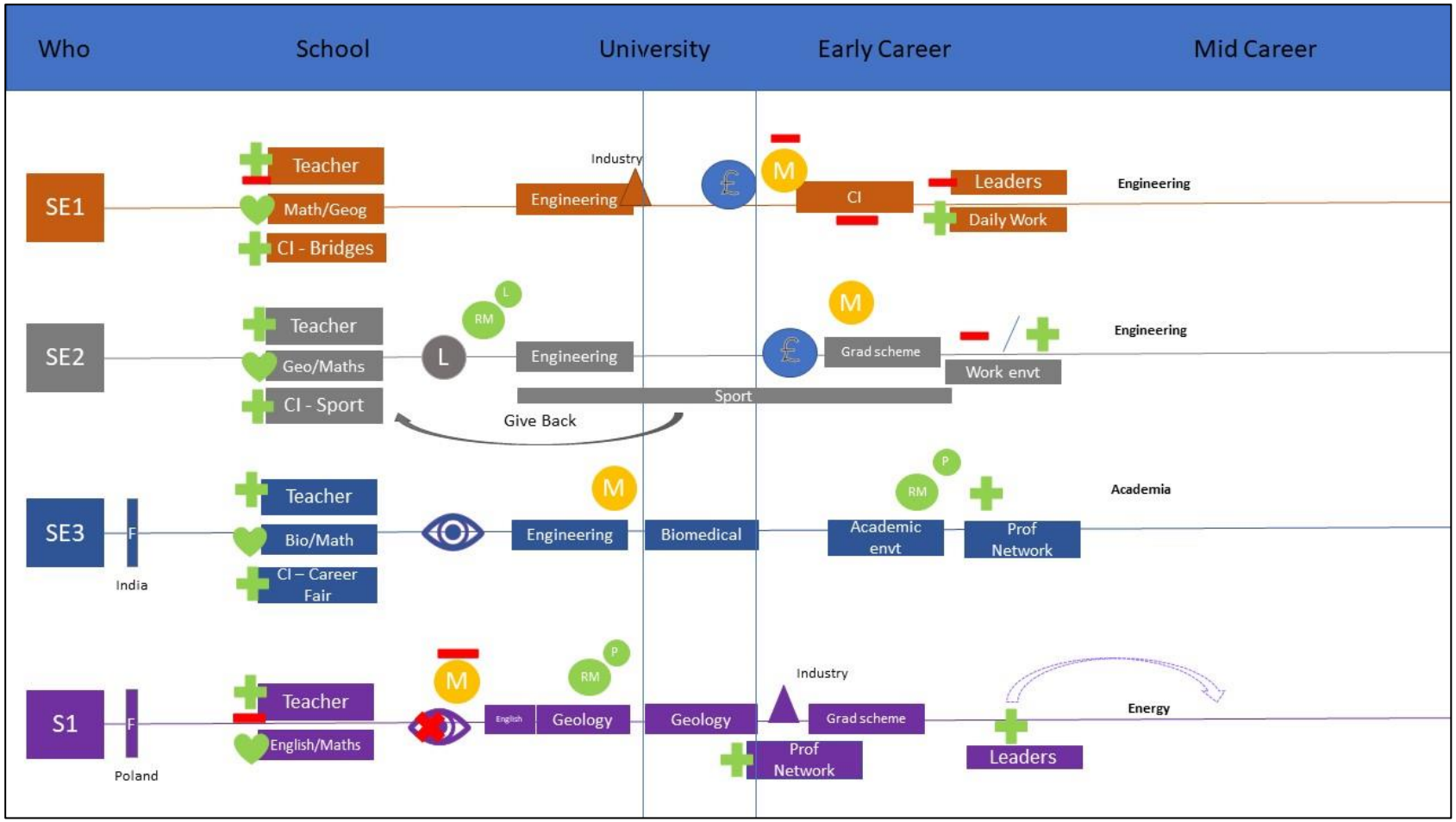
T1 had peer role models in Greece when she did her Engineering degree on a side project called 'Votes for Notes' and a negative critical incident in her early career

T2 found that the financial burden of studying required her to go into industry whereby she had some role models but lack of mentors

T3 had both positive and negative experiences with STEM teachers has a mentor now and role models with a positive work environment

T4 had early leadership experience and felt like school to university transition was a conveyer belt until a teacher stepped in and helped her to decide to take a GAP year, subsequently a mentor helped make decision to go back to Uni and the course.

Figure 4.2iii: Participants 5-8 Career-Evolution lines



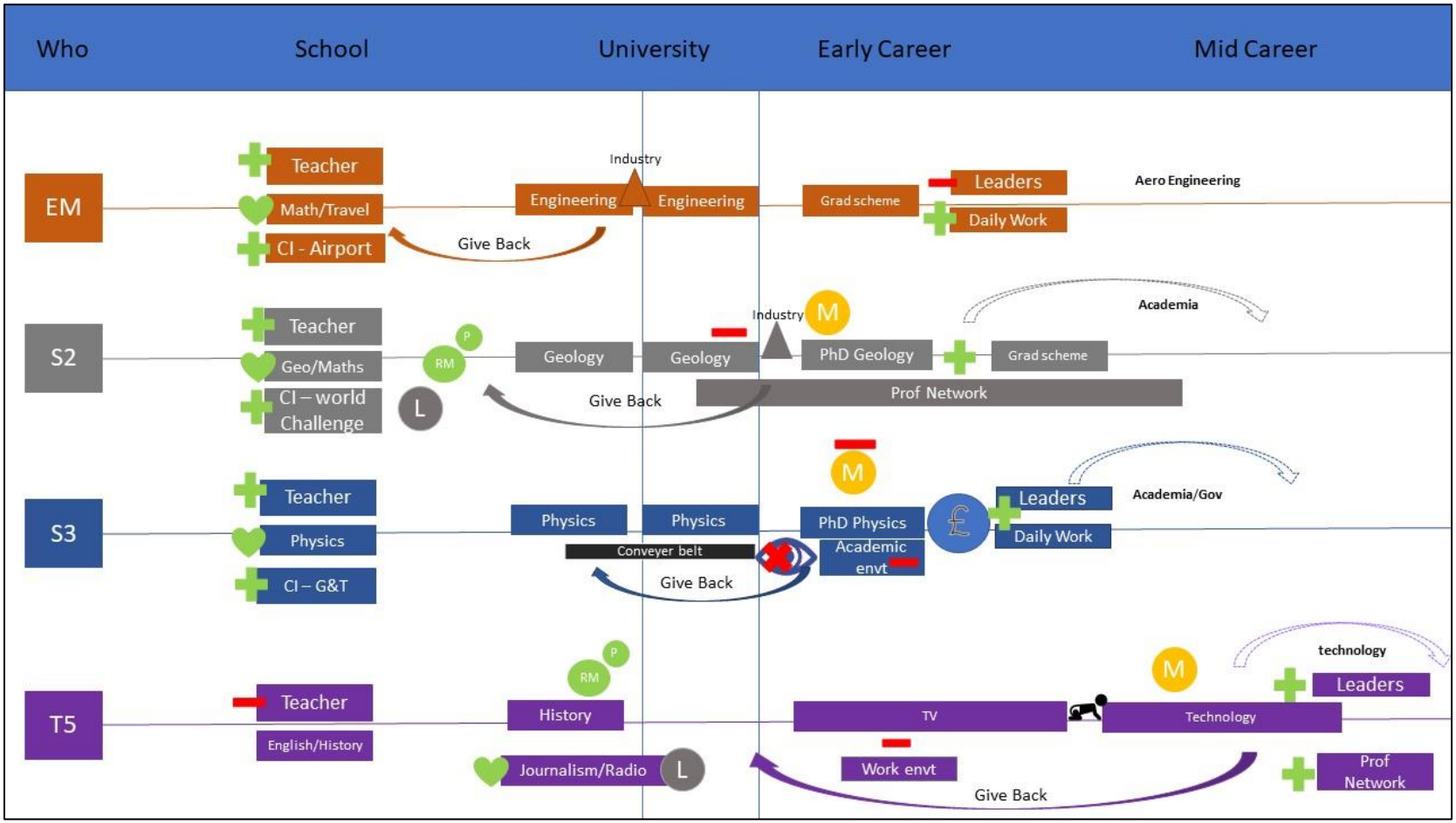
SE1 had positive foundations in Engineering where she was taken to see bridges her grandfather had built, in early career financial implications meant she needed to get work, but has had some negative experiences from leaders and lack of mentors

SE2 was given leadership experience and was exposed to role models in outdoor sports. This is a factor in her choice of career of engineering, but her work environment is mixed with some mentorship but negative work environments.

SE3 had an education in India and had positive experiences towards career choice via careers fairs, has had a mentor and positive peer role models and is positive about the future

S1 had mixed experiences with teachers and their roles in Poland, she had no mentors and, no line of sight for careers. She started on a pathway to study English but a peer role model influenced the change of direction to switching to geology and a positive career in the energy industry has followed.

Figure 4.2iv: Participants 9-12 Career-Evolution lines



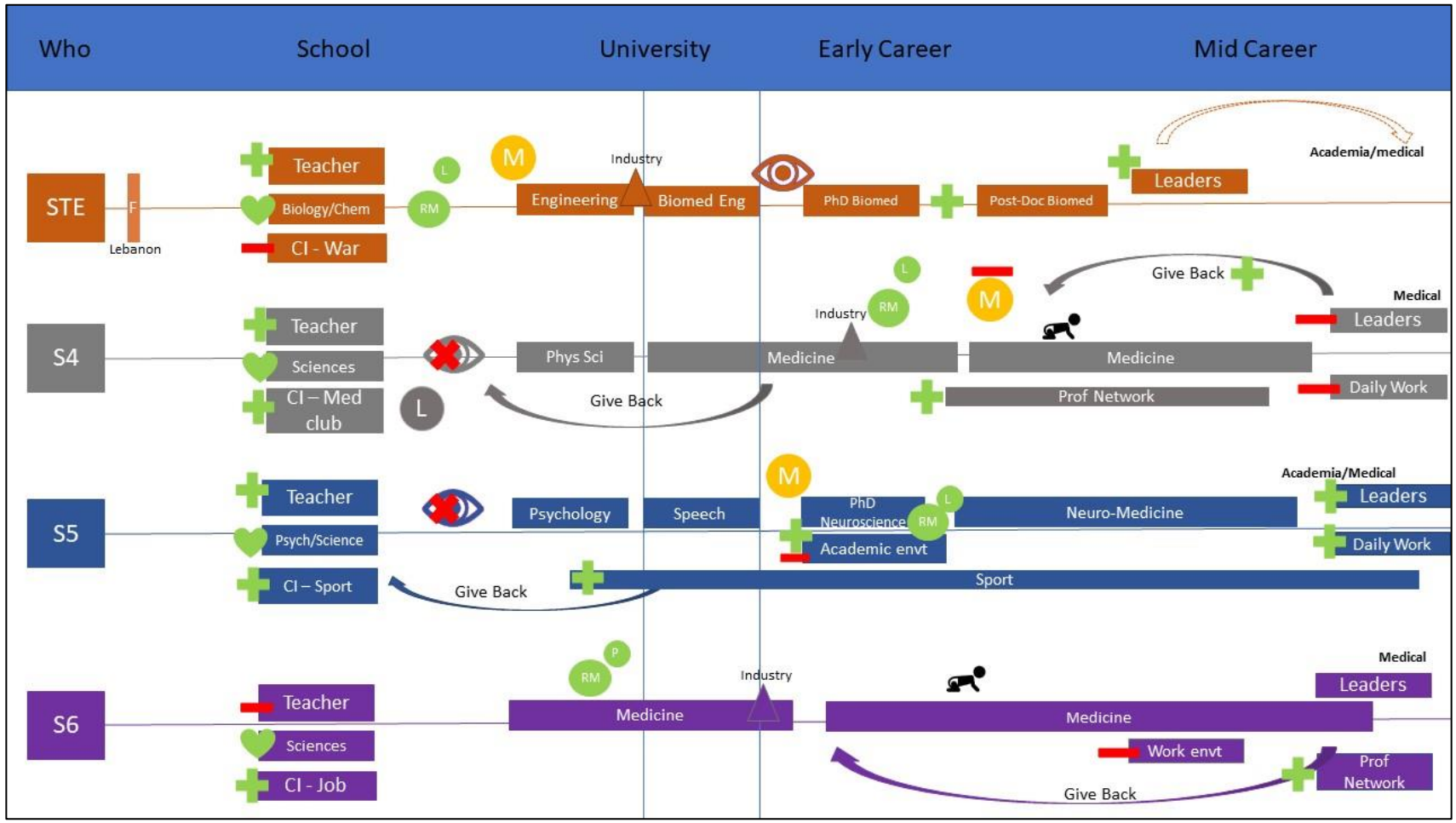
EM had a positive experience doing work experience at an airport which excited her to consider a career in aeronautical engineering, she was good at maths and volunteered at maths tutoring, currently she feels her daily work is positive, but is conflicted with the male dominated leadership.

S2 had positive schooling experiences and had role models and leadership experience early on. On reflection she found her experience with a mentor at PhD level would've helped if that was available or used earlier at BSc or MSc

S3 had positive schooling experiences but found that entering continued academic conveyer belt was toxic and unsupportive with no line of sight of the pure subjects which could develop into careers, she believed having a mentor would've helped and wants to do that for others.

T5 had an arts education and some unsupportive teachers, but a passion to follow journalism and television. The culture was not positive for a mother and her transferrable skills switched her into a tech industry where she leads and gives back via professional networks.

Figure 4.2v: Participants 13-16 Career-Evolution lines



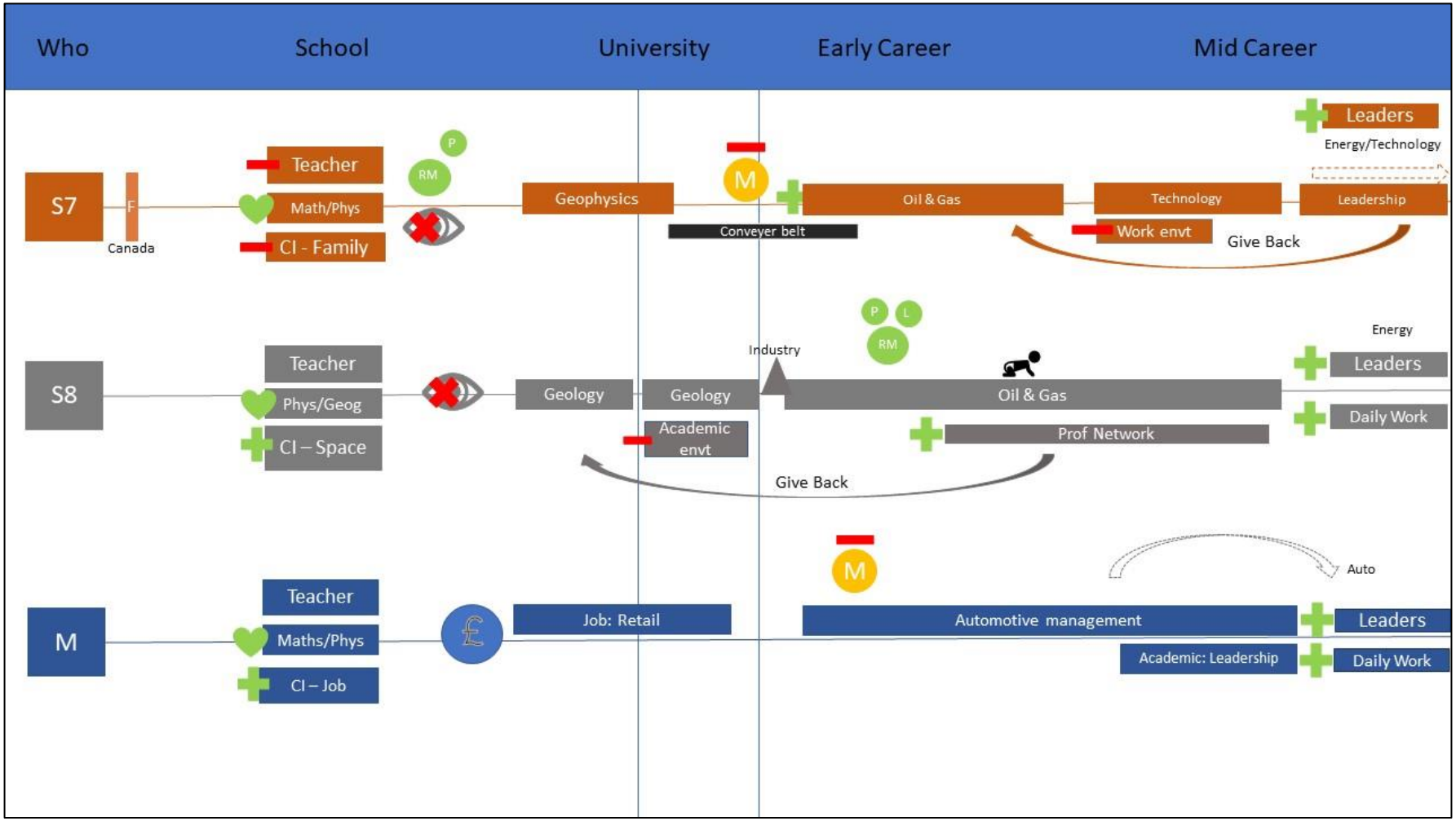
STE had an overseas private education which had plenty of support, role models and mentors. Despite war being a major part of her upbringing her continued career in academia and biomedical has been positive and remains so.

S4 had a positive incident at school being inspired to move into medicine, had early leadership experience, but at mid-career feels in the NHS she is not supported and is jaded by her leadership and daily work, had she had a better line of sight on careers perhaps followed another route.

S5 had positive schooling but no line of sight for careers, she followed her heart into psychology and in parallel sport. She noted there was toxicity in the academic environment, but role models and mentors and support network have made her journey more positive towards mid-career.

S6 had negative comments at school which she proved wrong and followed her path into medicine. She has experienced toxicity in the work environment and has made a change due to that, she gives back through mentoring and training now.

Figure 4.2vi: Participants 17-19 Career-Evolution lines



S7 had a negative start with family upbringing and teachers, but her peer role models took her onto a positive conveyer belt of roles from university into the oil and gas industry. She has experienced toxic work behaviour but is inspired by leadership and gives back.

S8 had positive schooling and inspiration at the foundation level but subsequent academic experiences were difficult and had no real career line of sight. She now has positive leadership experiences, role models, she gives back and uses her professional support network.

M had positive early experiences at school but enjoyed working, didn't want to leave and go to university, a career in automotive started and continued, with opportunities to have had mentors, but went back to university to do a leadership MA course.

4.4 Thematic Analysis of Career-Evolution lines

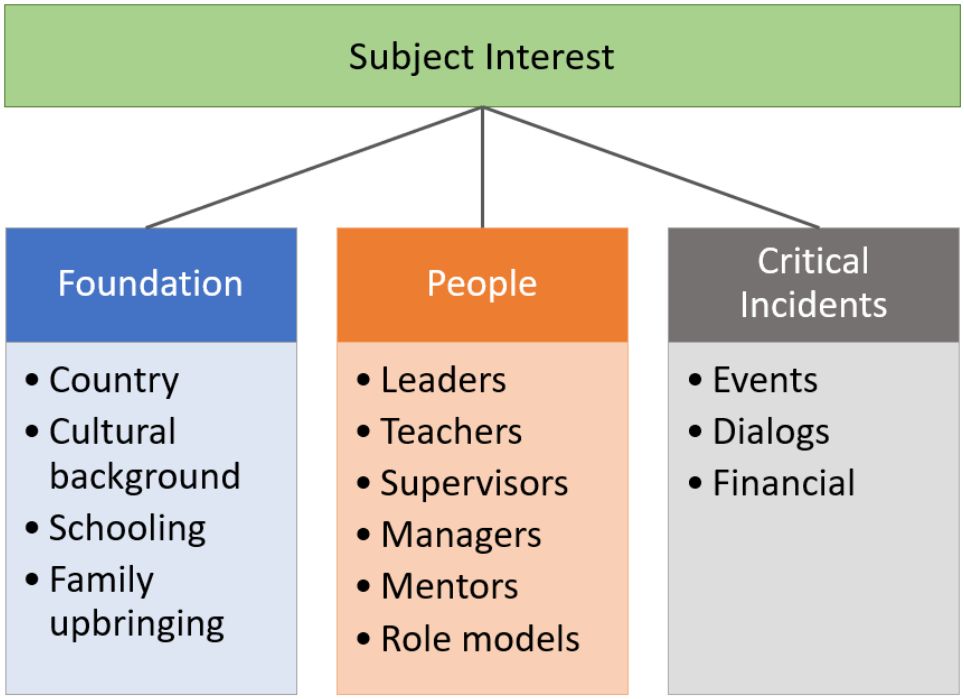
Based on the original research question it was important to see what themes had been exposed. Some were expected, but at a generic level and based on personal experiences. A semi-structured open questioned interview was planned to look for inspirational (or not) people that had motivated (or demotivated) them throughout their careers and what critical incidents (Flanagan, 1954) were involved in making their decisions.

Hi-level Themes from data:

1. Foundation
2. People and Leadership
3. Critical Incidents/Interventions
4. Subject Interest

Working backwards from the data responses and noting some expected themes based on initial literature research, what this analysis tries to articulate is a holistic decision-based career evolution. It shows the high-level factors influencing motivation of a subject to decide and a career pathway however linear or chaotic that might appear. Figure 4.4 shows the relationship between themes and sub-themes.

Figure 4.4: Relationship of Themes and Sub-themes



4.4.1 Foundation

- Country and cultural background
- Schooling
- Family upbringing

The foundation upon which you were brought up, the family background, country and culture all influence the responses and decisions we make (Rutter, 2008). The initial intent was to focus purely on females who are in the UK, this would allow a focus on findings specific to the UK schooling system and any data or recommendations following the study would be helpful to feed back into that system. The UK is a multicultural country with females from other countries now working here and some had their schooling overseas either as British citizens overseas or originally from other countries. This however lent itself to an added complexity in that the overseas school structure is rarely the same as the UK, (GCSEs at 16 and A-Levels at 18). During interviews with those who had been educated overseas it was necessary to understand the school system and how that differed from the UK. Also, on occasions specific countries cultural and religious beliefs was discussed and expectations of females. This was

all offered or probed in the interviews and was the perspective of the interviewee and not representative of the country, culture, religion generally.

Approximately 30% of participants were schooled overseas with different approaches to secondary education. India, Lebanon and Romania had a system whereby you narrowed down into groups of subjects, such as arts, sciences, humanities or business, but not specific to subjects as UK A-levels were. Some of these choices were based on school performance.

Most participants came from backgrounds where at least one parent was educated to university level and quite a high number had teachers in their families. What is interesting is some of the perceptions of female teachers and that in some countries is expected that females become teachers if they are smart and so look like the only career path for women beyond university, so they can continue with parenting or other work-life balance challenges..

Most participants had family members that encouraged them to follow their area of interest further. Nobody said their parents discouraged them to move into STEM roles.

The 'Subject Interest' in some cases was sparked by their family backgrounds – such as parents or grandparents being engineers, families spending time outdoors and enjoying finding fossils on the beach and the natural sciences became an excitement. In many cases there was reference to science as being curious and loving to understand how stuff worked. This will be covered in more detail in section 4.5.4

4.4.2 People and Leadership

- Teachers, Supervisors, Line manager
- Role models
- Mentors

Positive characteristics of various Teachers, Supervisors, Line Managers and other leaders are shown in figure 4.5 in the form of a weighted word cloud. Note that being encouraging, caring, confident and giving feedback are important attributes.

Figure 4.5: Weighted word cloud to show the positive attributes of Leaders from interviews.

Teachers, specifically in the science subjects, there were numerous responses that the good or amazing ones really bought to life the subject with concrete examples and applications to real life and 74% had inspiring or positive teachers.

> *'all my teachers were kind of nurturing'(S4)*
>
> *'all my science teachers at senior school were female' (SE3; S4)*
>
> *'having a report with the students, I think that's quite special*
>
> *'Teachers were just connecting on a human level.' (T3)*
>
> *'he definitely saw something in me, I wasn't really confident …but because of that I'm forever grateful.' (T3)*
>
> *'I had really bad physics teachers, which is ironic. I was the only girl to do A level physics in my year above and below. And I was consistently predicted really bad grades in physics' (S3)*

'He was just really open to exploring the teaching people maths in a different way. He wasn't just throwing equations on the board' (T1)

'I think it's quite interesting that the subjects I enjoyed and thrived in it was women in those teaching me them' (SE1)

'I definitely didn't feel very confident, she kind of inspired me… gave me confidence when I was struggling' (S5)

Role models

Interestingly when asked about whether they had any role models, some were very clear especially when it was a leader (37% had leadership role models), but most never considered peer friendship, support or community groups as role models until further probing and questioning happened, resulting in 47% of participants said they were influenced or impacted by peer role models. Surprisingly only 2 people mentioned hi-profile role models, all others were accessible and well known to them.

'she's definitely a role model… She would always, you know, encourage people to learn more… Still, as of today, she is doing amazing stuff' (T1)

'helping others, being fair, doing something really good, you know sacrificing personal interests over the common good, so all those. I think they do qualify as role model <peer>' (T1)

'one of my best friends, runs her own business that has been broken by covid and seeing her resilience…I find that very inspiring' (S2)

Mentors:

An unexpected observation was that, what worked and inspired some people, was lacking in someone else journey. An example and quote from **STE** who went to a private school who could not distinguish a particularly inspirational teachers as they '*were all amazing'*, she had

'lots of support available if I needed, felt I could achieve anything based on the culture it had built…then moving into university, had plenty of support, mentors were assigned to us and had a careers office which was a great resource'

'Having had a mentor say undergrad or earlier would have been very useful' (S2)

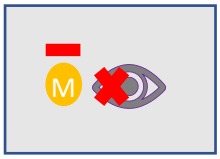
'doing more presentations of posters in the rest of my PhD, I think what would <My mentor> say? She would want a quick brief summary - don't waffle - What are the key messages?' (S2)

'It really helps to have a fresh perspective of someone who's not necessarily invested in whatever you're coming to them about.' (T4)

'that relationship that I have with her made me want to help other people in the same way, so I mentor.' (T4)

In the Career-Evolution lines these are noted with:

This is in stark comparison to many other participants who struggled to navigate the complexities at university and feel confident they had chosen the right path, interpreting that and asked them to reflect on what could've helped them during that time, some even told me that "*I wish I had a mentor back then*" or recognised that they could be a mentor themselves to help someone else struggling to navigate the world of, university degrees and what potential careers that would lead to. This came up numerous times that they had poor careers advise or line of sight from school to university to careers. In the Career-Evolution lines they are noted these with:



4.4.3 Critical Incidents/Interventions

There were several critical incidents that played a part in the decisions for interview participants to move into the careers they had, all of these were during adolescence. These can be seen on the Career-Evolution lines in figure 4.2 and noted as CI (Critical Incidents).

Some specific examples of critical incidents include:

Nicaragua world challenge

'12 of us, went to Costa Rica and Nicaragua built a school… we were going on hikes with the locals and eating with the locals. Living with people and teaching in the schools.' (S2)

F1 in schools

'You really are doing everything a Formula One team … Someone to look at the business side of things… you have to get sponsors… giving them return on investment, Engineering - testing behind the car. ' (T4)

Inspirational talks by medical specialists

'They had people the neurosurgeon who was trackside when Ayrton Senna had his fatal accident - you know really inspiring people!' (S5)

Visiting bridges built by grandfather

'That it <engineering> was inspiring and probably some of those actions of being on a tour round the country to see things that have been built by you or your family' (SE1)

Airport work Experience

'It took me onto the aircraft, had me shadowing maintenance engineers. Yeah, good, I know that's fascinating!' (EM)

Through the data analysis there were indicators of what was missing, not just what was common across participants. The event that stood out here was Careers Fairs.

Careers Fairs were pivotal in India, Romania and Lebanon. If interviews were with only UK educated females the analysis would not identify how important these Fairs were and the impact they had and the positive line of sight the participants had in their studies to career pathways. Interestingly, most participants said they had very poor careers advice, unless it was a specific teacher or role model that stepped in.

On the negative side of critical events, several participants were told that would not achieve something, whether that would be to get into a specific university, get certain grades, or achieve a certain career. This happened to 5 participants including myself, and all the responses went on to prove them wrong.

4.4.4 Subject Interest

This theme was separated out as sometimes it was independent of another theme. Incidentally, there seemed to be a passion, enjoyment or curiosity for a subject that was then increased by something else – an engaging teacher or a critical incident.

'Why is this Hill like this?' (S2)

'I really liked math, but I liked it when it could be applied to something.' (S7)

'I lived most of my life in a sort of mountainous region and you get two types of people, some are collecting rocks or shells, I was rocks.' (S1)

'I love the satisfaction of doing the math problems as well the getting to the end and getting the right answer' (S3)

'I used to spend hours sitting on my windowsill looking at the night sky at all hours of the evening' (S8)

4.5 15-year-old Self-Reflection Themes

Each of the interviews started with – 'I see you did X, Y, Z for A-levels, take me back to that time when you were 15/16 years old and tell me why you made the choices you did? What inspired and motivated you to do that?

At the end of each Interview the following question was asked:

'What would you say to your 15- year old self?'

By mining the transcripts of all participant's interviews, individual reflections have been pulled out all which are conveniently summed up by one quote which could not be themed.

> *"Your grades aren't the only thing that define you. There are other things that you'll come to realize that aren't that you can value" (T3)*

The themes and quotes are shown in figure 4.6 with the main themes being:

- Asking and seeking help and advice
- Being open minded and consider your options
- Follow your heart and do something you love
- Be confident and believe in yourself
- Not everything will go as planned, use these as opportunities to learn

Figure 4.6: Excerpt from themes for advice to our younger self. Full list in Appendix 6

These quotes show that many females across the STEM industries experienced similar reflections on their journeys and advice to their younger selves. These are not specific to STEM and are more broadly around behaviours and responses to situations such learning through experience and resilience. This advice is relevent to anyone youger irrespective of gender or potential career pathway.

4.6 Summary

The Career-Evolution lines became a bigger part of the study than anticipated, but helped to quickly look at similarities and insights across the participants and to tell a short career story visually and simply. While there are many more quotes and details regarding the data analysis, this study is too small for this scope. More work could be done using AI on the transcriptions, or looking at the reciprocity amounts of the interviews if we could look at percentage spent talking interviewer vs interviewee. I will go into more detail on the findings in the next chapter.

Chapter 5: Discussion

5.1 Introduction

The Microsoft study suggests that it is the lack of role models which channels girls away from STEM careers, and their recommendation is

> '*Having visible female role models sparks girls' interest in STEM careers and helps them to picture themselves pursuing these fields'.*

This section will pull together the literature and interview data to look at opportunities in education and industry.

5.2 Role Models and Critical Incidents in Education

González-Pérez et al (2020) study suggested that interventions of providing role models into schools this would positively impact student's likelihood to remain in STEM or consider further roles. By girls seeing someone in a role that they could see themselves doing, makes it easier for them to consider moving forward. Numerous STEM focussed societies in the UK (and globally) such as WISE, Cajigo, Stem.org.uk, all provide opportunities for people to get involved and create positive interventions with role models going into schools or other societies. With such large organizations and often specific focus areas (technology, coding, socio-economic backgrounds, ethnicity) it is challenging to reach all girls in schools with opportunities for role models to be involved, whether it is a simple talk, or whole day experiences run by these organizations. Some schools have dedicated STEM leaders, with programs run via some STEM organizations, conferences as well as their own passions. This is an area of opportunity that the STEM organizations are filling the gap, but more could be done.

A school STEM lead is quoted,

> *'STEM ambassadors (STEM.org.uk) is my main source – I get lots of ideas from there. The positive side is I don't get pushed stuff that is not relevant, and I don't have to be forced to teach certain things.' (STEM Lead Practitioner)*

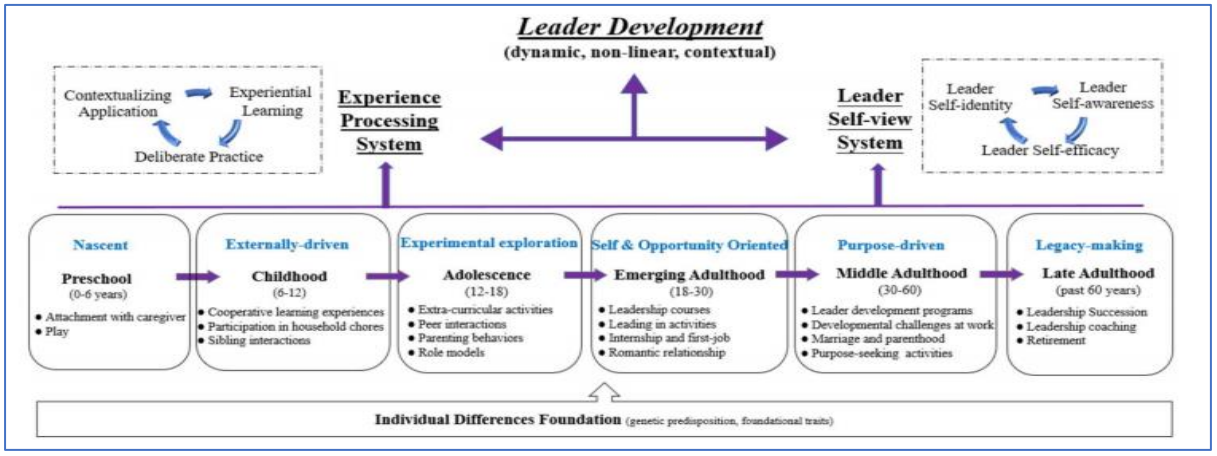
Several interview participants were keen to get involved themselves in giving back, whether this is as a role model figure in an intervention in schools, or as a mentor to someone doing their undergraduate degree. Figure 5.1 shows an example of leader development which suggests that during adolescence we are influenced by extra-curricular activities, peer interactions, parenting behaviours and role models. The interview data shows numerous examples of critical incidents (Flanagan, 1954) and experiences which influenced their future.

Some examples are:

- T3 encouraged to do drama to increase confidence, that leader was a role model.
- T1 peer role models in 'notes for votes' group (check)
- T4 was participated in formula1 in schools, ended up with a mentor and given leadership experience
- SE1 came from a family of engineers
- SE2 experienced sailing at national level and is now a national junior coach
- S2 attended a world challenge with peer role models and given leadership experience
- S3 family enrolled her in gifted and talented program exposing her to many science-based opportunities and discussed physics with peers
- S7, T5 and STE experienced challenging family circumstances influencing some key perspectives and decisions made later in life.
- SE1, S3, S5, S6 all experienced being told they were not good enough to achieve something and responded with wanting to prove them wrong.
- T4, SE2, S2, S4, had early leadership experience

5.3 Role Models and Critical Incidents in the Workplace

Figure 5.1: Leader Development. Adapted from Liu, Z; Venkatesh, S; Murphy, S.E; Riggio, R.E (2020)



According to Liu et al (2020) Middle Adulthood is the time to be purpose-driven, and emerging adulthood is a time to first dip our toes into leadership with courses and leading activities. Through the 'career stories' in this study this phase is as early as the emerging adulthood phase. Several participants already felt fulfilled when giving back and want to do more. This could be argued for several reasons. This might question if this is purely a female trait that females want to nurture and care about the next generation of females doing something they love. It is not clear in Lui et al's study (2020) whether the data used encompass both male and female participants equally. The paper was written in 2020, so very recently, however, there could be traits of different generations based on the speed of change, technology and societal and economic pressures and the authors are from an older generation. What could be interesting to study further is what millennials, Gen Y or Z have to say about their approach to leadership development compared to other generations.

Most females interviewed wanted or already give back in either the workplace or outside – as volunteers, leading sports in communities and the mid-career females in literature feel dissatisfied or isolated in their roles (Hewlett et al, 2008). Leaders need to make females feel part of their organizations. If there were mechanisms in organizations to have dedicated mentoring circles where females can feel a sense of belonging and feel fulfilled in being able to give back and be role models, this might be a good option. By creating positive critical

incidents in the workplace, - for example, engineer an intervention like González-Pérez et al, (2020) in the workplace and bring in positive female role models, this could be as an increase in female leaders within the organization generally and more emphasis and showcasing those already in the organization with inspiring events and a feeling of belonging. These could come in the forms of women's networks with a series of events to appeal to women.

Both literature (Fouad et al, 2012) and my findings show that there are toxic work and academic environments females are often subjected to. In some cases, these are gender related, but not all. Specifically, in engineering where there are even lower females than other STEM subjects, all engineers interviewed mentioned this:

> *'It's not the job itself, it's the environment that seems to come with it…I do believe that part of that is because we don't have the females at the top…As female-engineers go, there's no one above project engineers as a female.' (SE1)*
>
> *'He came to my desk and he said, "This is not how it should be done, Missy!" He was calling me the word Missy! … I felt I couldn't stand up soon enough because I didn't have the confidence.' (SE1)*
>
> *'There was definitely tension, and I felt very uncomfortable asking him to do stuff, so I'd usually phrase it as, "X has asked me to ask you to do this" rather than, "I want you to do this."' (SE2)*
>
> *'There aren't very many females in this sector or in the professions, or the courses that I've taken, I think people just tend to assume that it's not for females.' (EM)*
>
> *'I think they perceive you as soon as they see a female that maybe you're not as competent as they are, and I think the moment they see how you solve problems, how you work, your understanding of situations. And you see that flip in their reaction or their perception towards you.' (EM)*

5.4 STEM Networks and Organizations

Through continuous reading whilst researching this subject it was evident there were a plethora of organizations (I focused on the UK, but there are many globally) dedicated to increasing the percentage of females going into STEM subjects. A lot of work is on-going with STEM ambassadors (STEM.org.uk) and their sites showcase the work and impact they are having in schools with role models, STEM ambassadors in schools and being mentors and giving back to education (See quotes in section 4.4.2 People and Leadership).

This is fantastic for there to be huge organizations to help schools, but an area which the data analysis found lacking was for young females in the transition to university and then first career roles. It seems many were burdened by financial challenges, but many also said they would've looked for a mentor earlier in order to help them navigate different career options, organizations etc. Through further research and reading, many universities have alumni mentoring groups. It would be interesting to do further research and find out how effective and active these groups are. There are so many routes to volunteering and helping out, it is possible that those who do want to give back feel overwhelmed with the options, or it could be they don't want to feel swallowed up by large organizations and lose the intimacy of a one-to-one match with students from a school/college/university where you have a connection.

From these large organizations there is less focus on how to inspire females to remain in their STEM careers and become the STEM leaders. While these organizations are quite broad for STEM, we need to consider the professional networks an internal to organizations and their role in keeping females engaged and inspired by leadership in their profession and then directly within their organizations.

5.5 Follow your Heart

From the feedback in interviews both as a response to the, 'What would you tell your 15 year-old self?' and general questions on what motivated you to study that subject? There was a clear recommendation that if you have love or passion for subject AND you had engaging and inspirational teachers there was likely to be a high success rate of females moving into STEM subjects or careers.

Conversely it may be the case that this subject interest is key irrespective of whether it is a STEM subject or not. One candidate was following her graphic design and art route but ended up in technology looking at the Usability (UX) of software.

Financial implications were sometimes bottlenecks to following your heart and when UK University was funded for the mid-career doctors, there is a different challenge to today's incumbents in that they will be expected to pay for many years to study before making a salary, especially if there are multiple degrees or are long such as in medicine.

5.6 Summary

The findings correlate with the literature and the benefits of having a mentor (Haggard et al, 2010; Microsoft, 2017; Ibarra, 2019; Valerio and Sawyer, 2016; Welsh McNulty, 2018), and many organizations (STEM.org.uk; WISE) claim it is a good idea. The data suggests that mentors play a more significant role than role models but accessing a mentor or a valuable match wasn't easy. This is where companies and professional networks can step up and improve. Starting with mentorship as early as schools would make it seem normal once in university and could increase the confidence of females at a younger age group to remain in STEM.

Chapter 6: Conclusions and Recommendations

6.1 Introduction

The key findings and recommendations within education focus on increasing STEM career pathways for females whereas the recommendations to industry are to retain females so they reach their potential and the number of STEM leaders can increase.

6.2 Recommendations within Schools/Education sector

Schools and the UK education system needs to help increase the number of females moving into STEM from 24% of women in STEM to closer to 50%? Societal and foundational change needs to happen to make a difference for the next generation and the pathway to STEM careers and leadership easier.

Telling stories are inspirational, it doesn't matter how long the career or how simple it seems. Often the important parts of career stories are not what happened, but why you decided to do it and what was learned through that experience. There will be examples of resilience, overcoming challenges, taking chances, trusting your instinct and learning from failure that others can learn from. Schools have an endless supply of parents and STEM ambassadors who could simply tell their stories and potentially inspire the next generation. Sometimes it is not the big events, but the relatability of someone and how they handled the situation. The Career-Evolution line could be a mechanism in achieving this.

Mentors in Education. This is a relatively new concept to school age students and seems lacking (in UK) at University levels. There are opportunities to work with large organizations such as WISE, STEM.org.uk to offer yourself as or find a mentor. An organization could embark on a mentoring scheme with a local school or universities or personally contact schools/universities directly. When registering and working with STEM ambassadors (STEM.org.uk) in the UK, safeguarding training will be undertaken to be able to go into schools, otherwise consider mentoring alumni programs.

National Curriculum – The findings will be disseminated to the local Slough schools' education group and local schools. There are opportunities to increase soft skills education in Personal, Social, Health Education (PSHE) this could be gender stereotypes, resilience training, simple

leadership skills including goal setting. This might be a forum to discuss the disparity of gender-based STEM pathways and statistics

Take action and seek help – Many participants are keen to give back, for those wanting to get involved at schools/colleges/universities, don't wait to be asked. If you reach out and offer, rarely will you get pushback. They will help you work with them or look at other routes. Simple emails to science teachers can snowball into an entire programme. For schools, parents are a large source of realistic jobs that can be showcased in schools and can use a career journey. Turn parents into role models for more to be inspired, irrespective of gender or STEM.

6.3 Recommendations within Industry

Industry needs to increase the number of female leaders, but the number of STEM female leaders need to improve even more on the current 5%. Industry needs to listen to and act on what our early and mid-career females are seeking from their leadership to keep them motivated in their professions and inspire them into STEM leadership roles.

Transformational Leadership resonates with females for a variety of reasons, the characteristics that appeal, are that leaders need to be personal, caring, give good feedback, be clear, encouraging and resilient (figure 4.5). Many of these are compounded in the Four I's (Idealized Influence, Inspirational Motivation, Intellectual Stimulation and Individualized Consideration) of Transformational Leadership (Avolio, 1999) – Role models are important, but so is the Individualised Consideration which females want to prevent them from feeling isolated. This does not have to be a female but taking these Four I's into consideration would be good for an organization to keep females motivated and a sense of belonging.

Give Back - Everyone interviewed wants to give back somehow and some are already are doing this. This could be in the workplace as a mentor or coach, volunteering in the community and being a visible role model to others, whilst having the added benefit of positive social impact and visibility for your company. There are opportunities to mentor within professional networks and support organizations and with university alumni groups to help younger, less experienced proteges navigate the postgraduate academic world or

transition to a working environment. Organizations can facilitate this and will enable females (and potentially males) to feel fulfilled in their role and long-term career and not just their daily work.

Support and professional networks are critical to help females build confidence and feel supported. This can come in the form of joining and participating at professional networks – either presenting as a technical professional (papers, posters, demonstrations) and encourage them to be part of women's professional events, conferences and more leadership experiences such as Women in Technology; Women in Geoscience and Engineering. The best form of support that many who had experienced at some point in their careers as positive. This is important that managers and leaders not just recommend someone get a mentor but help facilitate the connections and where the right type of match could be made. Throughout this dissertation, it was expected that role models would be the most important factor but having a mentor and/or a coach especially during University and work transition is equally or more valuable.

6.4 Learning from Others

Quote from EM on career paths:

> *'I think that's a big challenge and I think it's very difficult. When you're 16 you're really young. You don't know what you want, most teenagers that age don't know what they want to eat for dinner, let alone deciding what they will be doing for the rest of their lives. '*

It is challenging for students to have line of sight from academic subjects – maths, chemistry, physics, what a degree involves such as engineering and then a job. You are considering that you know what you want when we have also heard that people should look at other options

Careers fairs overseas had a positive impact with only a small sample of participants, there are potential learnings from these countries about how their careers advice is handled. There is an opportunity for careers advice in schools to improve and that it could form part of the national curriculum and national careers fairs, with organizations and universities in attendance. These do exist but would be interesting to look further at the effectiveness of these events. These are more viable options now that we are heavily virtual at present due to

COVID. This has not been investigated further beyond the findings in this study and careers advice and fairs may already be improving in the UK and worthy of further investigation. The internet has sped up and improved transparency about careers as everything can be searched. This can be a double-edged sword as students could assume everything is fact, rather than opinion, can be overwhelmed and that teachers have unlimited extensive knowledge and are often trusted implicitly. By being able to connect and discuss what a role would look like with a mentor, or a mentor can help connect others, this could work as other countries have done.

The UK structure of narrowing subjects as early as age 14 has impacted many participants, three ended up doing evening classes to supplement their A-levels for University entrance criteria. Other countries refine in bundles of subjects based on interests: humanities, sciences, business, arts and other not at all. While there is no perfect solution, making students more aware of the line of sight that specific subjects are required to move into certain careers – that's if you even know what career you want to do.

6.5 Career-Evolution lines

The Career-Evolution lines were generated to make sense of the rich depth and breadth of data from each interview participant through their career journey. The impact this technique has had on the project and feedback from people who have seen them is positive. This technique has had serendipitous benefits above and beyond this study. This technique could be used to look at certain demographic groups, within or across organizations at different levels of experience to see if there are any themes or similarities within a single company or sector. This might give some more specific insights that would be relevant to Technology or Engineering.

This method could be used in several ways, focussing on a single foundational theme – any similarities from single sex education or select all participants that have had mentors to see where they had an impact and what that was. This could be in a careers session with all talks following a simple evolution line and concentrating on what impacted the decisions made (people/events). The use of this technique could be beneficial in many ways and future studies.

6.6 Limitations of the Study and Options for future study

With such rich data and the breadth of themes which impact female motivation, time was a factor in how much research, reading and relevant material is on offer. I have barely scraped the surface and for each theme an individual dissertation could be done on it.

By bringing both leadership and STEM into a single subject, it was challenging to explore different types of leaders separately. It would have been preferable to dedicate a section each on Teachers, Supervisors, Managers and other leaders. This was not feasible in the size or scope of this study but could be considerations for the future.

Throughout the study there have been suggested areas of further study at the time but to recap some of those include: the use of AI tools in data analysis of the recordings and transcripts; the comparison of different generations approach to leadership development; the effectiveness and activeness of alumni mentoring groups; the existence and effectiveness of careers advice and fairs in the UK for student career pathways.

The subject of females in STEM and the impact of mentors in improving numbers of females in STEM Leadership roles, would warrant further dedicated research that this study could provide a good foundation and evolve further.

Chapter 7: Reflective Report/ Personal Reflection

7.1 Reflections on Research Topic

Reflecting on the decision to select the topic of females in STEM, my initial reaction would be that it seems to have been both a blessing and a curse.

The two areas I decided to focus on was female leadership and females in STEM.

Both these areas of research which although affects me personally and directly, the amount of resources, academic, journals and focus groups is immense, and I have not managed to scrape the surface in reading the literature. It is the passion and personal connection I have with this area of research that I felt was natural to work on, but I had to ask myself what else could I bring to this subject area? What could I contribute to an already overwhelming area of study and make it my own and personal to and for me?

The journey to focus on this research topic started at the beginning of my MA in Leadership. This course unlike many of the cohort was not sponsored by their company and so that left me with the freedom to look at other subjects than something which was based on my role at work.

During an Action Learning Set (Revans, 1998), there was posed to me the great question 'What do you want to be known for?' Having learned to reflect more (Kline, 1999)– a skill I have improved on during this course and have suggested to my peers – I had truly struggled with my personal career journey. Having spent 20+ years working in a niche area of geoscience and technology, I felt both the need to give back, and potentially question my role working in Oil and Gas from a social responsibility/conscience perspective. The challenge remained that I might need to move industries altogether as the energy transition rightly is happening.

Following on from my ALS I committed to act on what I wanted to be known for and so an exciting parallel journey started to my work and role in Shell. In my introduction I discuss the 'A-ha moment' I had during a STEM careers session I co-created with Harpreet as the STEM lead practitioner at Langley Grammar school. It was this realization that I am a role model and inspiration to younger girls. It is the work and journey I have taken that when I spoke openly

about the challenges I had faced and overcome, but all the exciting and fun parts too, made the journey feel accessible to others. By going back and telling my story from the age of those students and the decisions I made and why, that also I had made decisions for a reason (dropping chemistry because I didn't like the teacher, and couldn't link it to anything practical that I could ever do with it), yet ending up the path I did and taking geology for a degree, I absolutely needed chemistry GCSE. This was an example that resonated with students who really don't know what or where their life will take them at 15 yrs old when they start to narrow down subjects at school.

My roles at Shell and at Halliburton saw few women in leadership roles, yet I am one. With the impact of the energy transition, what did the future hold for me as a female leader in an area I have identified with for over 20 years? This subject would offer me insights into other STEM professions and the positive and challenging times they experience including the non-STEM related transferable skills and leadership skills required to move across sectors for female leaders.

7.2 Reflections on Personal Learning Objective

The positive experience at school running the STEM careers workshop for girls and the parallel with working in a male dominated industry with low levels of females in leadership positions, made this subject a natural choice and the way I approached it was that I wanted to hear the stories of other females, how they got where they did and why they made those decisions. I essentially looked to replicate asking the participants to tell me their career journey. The difficulty was then how easily I can convey all that rich data into something useful and tangible to do something with.

I am quite creative and not always keen on looking at how other people represent data but considered how I could generate a method which was fit-for-purpose, but equally told a story. The Career-Evolution line was born and a new method to visualise career journeys along a time-based evolutionary line. I discuss this benefits in section 6.4, but on reflection I feel more emotional attachment to these lines and how powerful they could be at telling stories in a simple way and am excited for the possible future of this technique.

I am a pragmatist in my learning style, (Honey & Mumford, 1986) and shown in Appendix 7. I needed to learn about the data collection and analysis tools expected of me to complete the

qualitative research method. This was a stretch learning approach for me, was something I hadn't done before and found challenging personally for a few different reasons.

I get excited and passionate about things and want to act on something as soon as possible in my work environment, I have a 'can-do' attitude and will often implement solutions and recommendations and start working on things quickly. I find it frustrating to wait out a process to wait on analysis. By adopting Schon's (1983) framework of reflecting before, during and after an action helped me try to keep each interview as a single entity and not let the data feed into the next. I also annotated any themes afterwards which emerged quite quickly.

It was important to reflect and put space between the emotions of the interviews and the dedicated data analysis and finding new insights and themes doing word cloud counts and trawling the transcripts afterwards.

I found that interviewing 19 people over a few weeks at the same time as full time work, doing this during a pandemic was tiring and intense, and what felt like little progress being made except acquiring more and more data and the thought that it all needs to be analysed. This was quite overwhelming at the time and having to remove an entire section on the analysis of the interviews themselves felt challenging.

On a more positive side, this kept me buoyed was the fact that I was listening to some wonderful inspiring stories and females who are all keen to give back in different ways, some looking for guidance and others already doing amazing work. Once the emergence of some key themes happened and I just enjoyed meeting and speaking with new people - my primary strength in Gallup StrengthsFinder 'WOO' – win others over (see Appendix 7) – I just learned to relax and enjoy the process a little more and became more comfortable for myself – and I hope my participants. I used Honey & Mumford (1986) learning cycle to look at the adjusted format of the interviews. It was clear they were too chaotic (my reflection), based on that, I created some principles and took advice from an interviewee (see section 3.6 on feedback and adjustments), then implemented the changes for the subsequent interviews.

I had to practice being patient. I had some themes which emerged, but by having a structure to follow and to separate out the data analysis and get the evidence from data I needed to prove that certain recommendations I knew from experience and gut feel were proven by the data, was immensely rewarding.

I have seen first-hand how useful a mentor and coach having has been, but how can I prove or disprove that this is could be the case for females in general.
I had personal experiences that I am sure others had gone through and had general conversations with others, and 'oh yes, that happened to me' but how rife were toxic cultures and low expectations of females compared to our male counterparts?
On several occasions in the interviews I internally smiled when I got evidence of something that I had a gut feel or hunch about.

The process challenged me to be systematic and thorough looking into the data, rather than going on my instinct. The school STEM session was instinctive, and I felt it was the right thing to do, mainly as I found it positive for the kids and myself, but what data did I have to prove that this would be successful?

7.3 Lessons Learned

I used a simple AAR process to look at what I planned to do, what I did and what could've been done differently. I am glad that I changed the interview structure somewhat after the first 3. Although it seemed counterintuitive to change something once, I had started, the scientist in me wanted everything to be as measurable as possible so asking the same questions to people in the same order.

I soon realised that to get the flow right and the right 'feeling' in the interviews, the participants needed to tell their story and not me asking a series of questions. The beautiful thing was that it eventually ended up as them telling a chronological story of what they did and why they did it, but me signposting questions and to probe a bit further when there were leads to be followed. In a couple of cases this meant we got bogged down in details in places and went down some dead ends, but I felt I improved over time. Once people were talking, they rarely wanted to stop until they got to present day, which was the intention.

The interview process itself I felt was very successful, but I don't this I have really had enough time to do the analysis more justice. With such a breadth of themes that influenced why people made decisions, I felt sometimes that 2 or 3 responses made a theme, but perhaps

would like to incorporate some quantitative questions and become mixed methods to be able to draw better conclusions. A large proportion of the findings and conclusions were a confirmation of instincts and a compilation of strategies from literature, recommendations already out there in the public domain. What I am probably more curious about is complexity of advice we are given including positive, but a reality of our cultural and educational foundations that impact our decision-making more than we realise and our individual personal circumstances we find ourselves in.

7.4 Future Aspirations Regarding Female Leaders in STEM

While my recommendations looked at joining organizations to get involved, I know that I still want to have an impact locally and that is what is important to me. I also realise that as a STEM leader myself I want to make the route smoother for the next generation of females at all levels. This means that I want to have an impact and inspire students, but what can I and others do in the workplace to ensure we have the best possible talent being our leaders of the future. I need to encourage and drive females to get coaches and mentors as they seem to be instrumental in the success of our future leader's positivity, self-belief and confidence.

Since embarking on this dissertation, I am more aware of organizations and have registered myself as a STEM leader with STEM.org.uk, I can then utilize the power of a large organization but have an impact locally. I plan to report this to the industries I interviewed from and have started to talk more openly about inspiring the next generation of STEM leaders at Women in Geoscience and Engineering (WGE) – part of EAGE and within Shell at our women's networks. This study has enabled me to open doors and start conversations with different groups and to talk about my passion and not just my daily job, but how that also affects my daily job. A win-win I would say!

7.5 Reflections on the MA in Leadership Course

I was attending this programme as a result of winning an essay competition in the Sunday Times by answering 'How can leaders provide stability in unpredictable times?' At the time I was quoted 'I am going to see other people's perspectives.' (Lynch, 2019). A large proportion (40%)? Of our cohort came from health services and a few other sectors. I am used to working either in Technology companies or oil and gas and have done so for over 20 years of my career and so I have been introspective of my field.

As we commenced the programme as Cohort 4 and started to look at our baseline of leadership experience, other courses or techniques we had used or experienced. I quickly realized that this was going to be a fascinating couple of years with these people and we shared one thing, getting through this course while working. Most of us had not undergone further education of this level whilst still managing and leading people. At the time we all enjoyed being away from our regular work for a couple of days dedicated and at Greenlands focussed on our leadership studies. Little did we know that a global pandemic was to change all that, the dynamics of physically being present and dedicated to our studies was to blur as the whole world became online and all we could do was support each other via social media and the course no longer became separated as much from our daily life and jobs.

Personally, I didn't feel this impacted me too much as I was used to working virtually, but I missed the camaraderie and face to face discussions with cohort members. When we did meet online, I was pleased we had met in-person at the beginning so we could move into breakout groups and know each other enough to participate and be empathetic to each other's personal experiences, what was challenging and disappointing is that I didn't get to see the perspectives of others as much as I had hoped. Due to the fact many were in health care and this was heavily impacted during COVID, some had to step away from the course and others who remained irrespective of sector was diverted to 'coping and managing' to just get through the course and not getting as much out of it as if we'd been face to face and many dissertation topics focussed on this new way of working and leading.

The course outline felt very natural in that it built up skills from theory of leadership and the wealth of frameworks, models and perspectives to implementing some of those different frameworks, models yourself and ultimately via other people, determining what are

appropriate approaches for others might not be the same as those for yourself. While I have enjoyed each module for different reasons, the biggest learnings I have undergone are:

1. The ability to spend time thinking and reflecting on my own opinion and perspective.
2. The ability to critically analyse academic literature and not take everything at face value.
3. The ability to select what is relevant to me but being aware there is other work available.
4. The ability to implement content directly from the course in real-time to my daily work and with peers.

While the process of writing an assignment was a skill I had to learn and practice, I felt the real value was gained by being able to use the information or techniques I'd learned either in my role at Shell, or with my parallel passion of giving back and developing the future generations. It has made me feel more confident in reaching out to strangers to work on projects – whether that was HR at work, teachers in schools or leaders of conferences to ask if I could speak. I have realised that there are many opportunities out there and people are often keen for others who care about that work to be part of it and get involved. Rarely did I get any pushback or anyone unwilling to help, on the occasions I did that was primarily due to COVID challenges and have since reconnected with those groups and reignited the conversations.

As a result of the modules on Personal Leadership Development and Practice-Based Leadership I have had more opportunities to work alongside local schools in Berkshire and have worked with Women in Geoscience and Engineering to deliver engaging virtual sessions on Inspiring the next Generation, have extended my STEM network to Technology leaders in the UK and will present in Shell through this year.

As a result of the Coaching and Mentoring elective, that set the scene for me to look at the importance of having coaches and mentors for me personally, what I can offer others and their relevance and importance in this dissertation. I now mentor two young leaders and have done cross-training within my leadership team on coaching techniques and the value of asking good questions as a leader and withing projects. I am keen that young females know the

importance of having a coach or a mentor and how that can help them succeed, which I also driven by the data from interviews in the dissertation.

The Responsible Leadership module and Mobilising and Maintaining Organizational Energy elective were timely based on the added challenges I faced in the workplace due to COVID-19, but also the accelerated response of Shell's towards the Energy Transition and followed was the largest reorganization the company had undergone. These courses gave me insights in how to respond responsibly to some of the social responsibility we have in the climate debate, our role as leaders and standing up to ethical challenges as well as managing our teams, their workload when working in unpredictable times, virtually and going through an uncertain future.

The opportunity to work closely as a leadership coach as part of Developing Leadership in others was a good round off to the course as it touched on multiple elements I had learned throughout the year, whilst also thinking critically and using my coaching skills to ask what this leader wanted and needed from me.

While I am positive about the modules I did take, the main criticism is that I would've preferred to take a module on Digital Technology Leadership that did not go ahead. While the material is available to utilize from Canvas, I already feel challenged in the amount of bandwidth I must devote to it and cover in my own time. With my background in being a trained facilitator and an elective on Facilitation for leaders made my curious about the content of that elective too. I fear I will never really know or have the time to delve deeper and feel that you could go through the programme missing out on some very rich material. By my nature I am excitable and curious and have to be careful I don't take on too much Since starting this course I have been much better at managing my time as I had so much to do at home, at work, on the course and during a pandemic.

In summary, I have found the experience, modules and structure incredibly valuable to my leadership experience, but sadly not able to enjoy the face-to-face connection we hoped the course would continue with due to the pandemic. I realise this is out of our control, and I hope an improved hybrid delivery method is considered for future courses to include social elements and working/networking with our colleagues, even virtually. The pandemic has

been difficult for many and I hope there are some positives which can come from it and I still stand by everything in my original essay about leading during unpredictable times:

'…be bold and curious, be vulnerable and open to improve, be strong and resilient; make it personal but don't take it personally.' (Scully, 2019)

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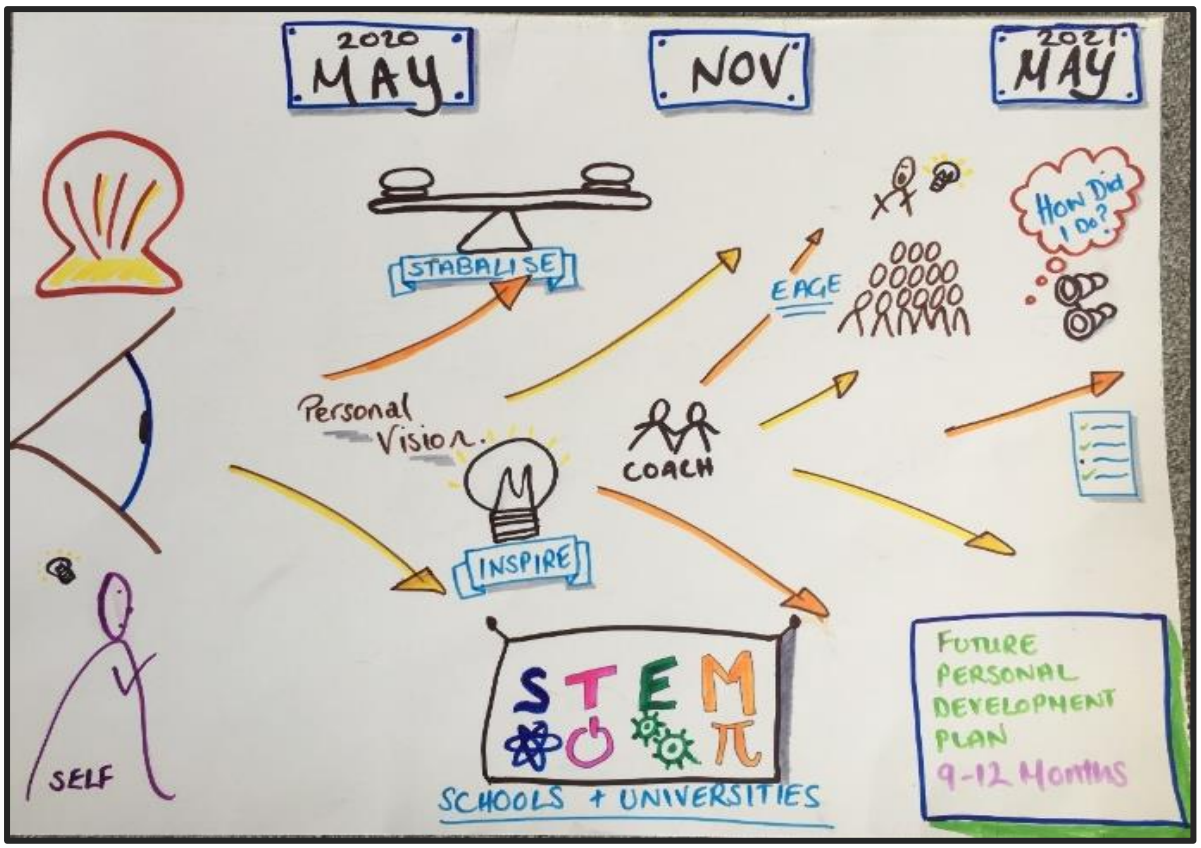
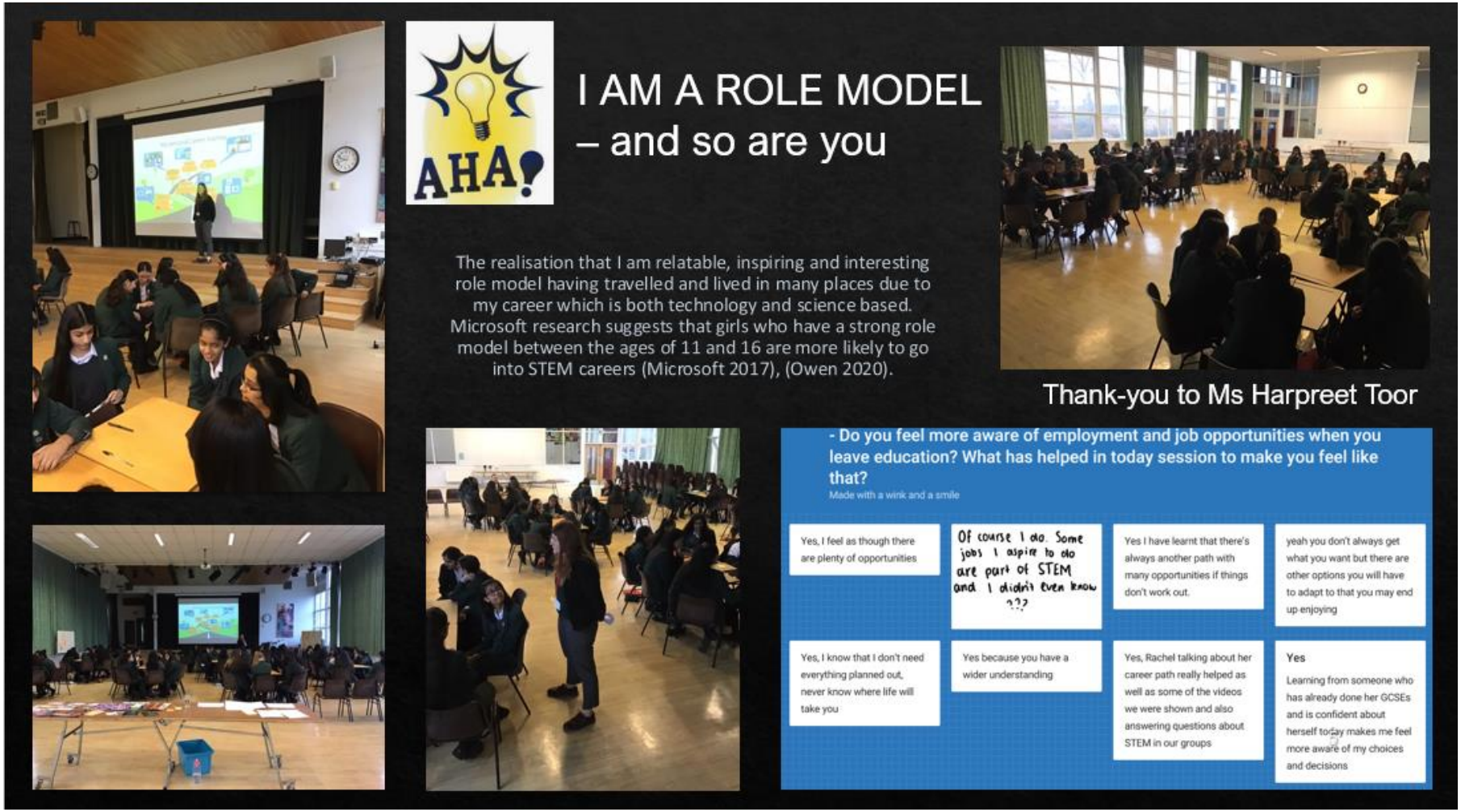
Appendices

Appendix 1: Personal Development Plan




I AM A ROLE MODEL
– and so are you
AHA!
The realisation that I am relatable, inspiring and interesting role model having travelled and lived in many places due to my career which is both technology and science based. Microsoft research suggests that girls who have a strong role model between the ages of 11 and 16 are more likely to go into STEM careers (Microsoft 2017), (Owen 2020).
Thank-you to Ms Harpreet Toor
- Do you feel more aware of employment and job opportunities when you leave education? What has helped in today session to make you feel like that?
Made with a wink and a smile
Yes, I feel as though there are plenty of opportunities
Of course I do. Some jobs I aspire to do are part of STEM and I didn't even know ???
Yes I have learnt that there's always another path with many opportunities if things don't work out.
yeah you don't always get what you want but there are other options you will have to adapt to that you may end up enjoying
Yes, I know that I don't need everything planned out, never know where life will take you
Yes because you have a wider understanding
Yes, Rachel talking about her career path really helped as well as some of the videos we were shown and also answering questions about STEM in our groups
Yes
Learning from someone who has already done her GCSEs and is confident about herself today makes me feel more aware of my choices and decisions

Appendix 3: Email invite for interview participants including ethics and consent

Dear…….

Thank you for your interest and hopefully offering to be interviewed.

As part of my MA in Leadership at Henley Business School I am undertaking research for my dissertation.

The title of my dissertation is:

An exploratory study of the motivation of females moving into professional Science, Technology, Engineering and Maths (STEM) careers.

I plan to do a series of interviews to both early and mid-career female leaders to understand what has inspired them and what continues to engage them in their profession.

To address the objectives of the study it is important to understand the experiences of both early and mid-career female leaders who are in early or mid-career Science, Technology, Engineering or Maths (STEM) professions.

I would really value you contributing to my study and be willing to be interviewed. If you agree, the data will be collected via a structured interview format will be conducted on MS Teams/Skype and will take approximately 60 minutes.

With your permission I would like to record and/or take notes for later analysis.

A copy of the completed summary of findings will be available upon request.

If you agree to participate, you are confirming that:

- You understand the aims of the study and how your data will be used
- Your participation is entire voluntary, you can choose not to answer any particular question and you can withdraw your data at any time without reason.
- At every stage, your identity will remain confidential. Your name and identifying information will not be included in the final report.
- The identity of your organisation will not be included in the final report.
- All data will be stored securely and will be destroyed at the end of the study.

The project has been subject to ethical review in accordance with the procedures specified by the University of Reading Research Ethics Committee and has been given a favourable ethical opinion for conduct.

If you agree to take part, I would be grateful you would

- **Send a reply email that states that you consent to the questions in my email**

Please note by giving consent you are agreeing that you are over 18 years of age and are willing to participate based on the information described in this consent form as they relate to the nature of the project and your participation.

Once you have responded by email, we can schedule the interview. Please let me know when a good time would be. I can do during the day (time dependent) or evenings/weekends over the next week. I am attaching the hi-level questions for your consideration prior to the interview.

Thanks, and Regards
Rachel Scully

Appendix 4: Introduction to participate in study

Hi

My name is Rachel Scully. I am a geoscientist by degrees and have worked in both technology and geoscience throughout my career at multiple levels in the Oil and Gas Industry. My current role is a geoscience technology deployment manager in Shell, and I am currently doing an MA in Leadership at Henley Business School.

The title of my dissertation is:

An exploratory study of the motivation of females moving into and remaining in professional Science, Technology, Engineering and Maths (STEM) careers.

I plan to do a series of interviews to both early and mid-career female leaders to understand what has inspired them and what continues to engage them in their profession.

I intend to interview 2-3 females from each of the following sectors

Automotive	Oil & Gas	Engineering	Teaching
Telecoms	Technology	Biomedical	

The aim of the interview is to talk to you about your experiences that have influenced you in moving into a STEM profession.

All data will be anonymous, and I would like to use the data to build up a set of recommendations that will be presented back to:

1. The organizations and industries from which the interview candidates belong. Would like to propose strategies that will help them retain and inspire their female talent.

2. Schools and education departments to ensure girls are set up for success in moving into STEM careers

This would be in the form of an hour scheduled interview with the following hi-level questioning, both looking back on your inspirations and forward.

Appendix 5: Hi level Questions sent via email to participants

Key demographic data:

Name, Age and experience bands

Career to date information

Educational experiences:

Type of school, University and courses

What inspired you to pursue a career in xxxx

What did you find inspiring at school academically or leadership related?

Who? What? Why?

(probe Role models, critical incidents and why)

What leadership experiences were you exposed to at school age (can be out of school)

What influenced you considering further education in STEM?

Professional experiences

What influenced your decision to move to the organization you did?

Who, What, Why?

(probe Role models, critical incidents and why)

What professional networks are you involved in and how does that support you?

What will make you stay in the sector?

What and who inspires you in the leadership you see today? Why?

What would you say to your 15yr old self based on your experiences?

Appendix 6: Full list of Themes for advice to our younger self

Being more open minded. I definitely wasn't so open minded when I was young	Tell myself to be more open minded and explore options and availability around me.
I was lacking confidence and I would say to myself just not worry too much about things and not to pay too much attention to other people	Different people have different ideas of what they think you should do, but it's down to you to really work out what it is you want to do and listen to other people's opinions but trust your gut
If problems feel too big an just focus on the next step and take it one step at a time.	...go for it. You can do it
You will be absolutely fine	Tackle any difficulty or obstacle with curiosity, courage and compassion and that includes self compassion. And that includes self compassion
There will be bumps in the road, you'll fail and you get up again, but that's all that's going to happen because that's how you succeed	Be brave and keep the curiosity alive because then you are going to go ahead and achieve so much more and you're going to succeed and do what you dreamed about
...and not to be scared of things	Ask questions, ask for help, ask for input, ask for clarification because I can see my daughter not doing that and being repelled by the thought of doing that.
Don't be discouraged by anything or anyone else	Make use of all the knowledge and the information and experience that you've got around you
And there are options even when. Even when it seems like there aren't that, there's still options.	Find some real people and ask some real questions and go see some real stuff

Don't worry too much, you'll figure it out.

And to work hard, so that should tell myself to work harder.

It isn’t always going to be perfect and you're going to make mistakes. And I think the most important part is what I've learned is owning your mistakes

Do something that you love

...you can do it, you will get there because there's a lot of doubt.

Do what you enjoy because things just follow you, you will find your way

It's OK to experiment and not know the answers.

Don't think that you have to decide on what your career is now because probably what you're going to work on in the future doesn't even exist now

Your grades aren't the only thing that define you. There are other things that you'll come to realize that aren't that you can value

Having had a mentor say at undergrad or earlier would have been very useful.

Actively seek role models earlier because I feel like I didn't.

Believe in yourself a bit more

Stay focused, make sure you know what you want and you're happy with where you're going before. You won't make any rash decisions.

As long as you’re trying your best. That's all you can do

It's OK to fail because that's how you learn.

Keep going, I think this is the right path, I don't know for sure if it is. I'm still figuring it out myself.

Pursue things that really motivate you and there will be a way to apply them somehow

Brace yourself because you're going to suffer a lot.

And not be afraid to change my mind, it's not a failure to try something and then decide that it's not for you and go a different way

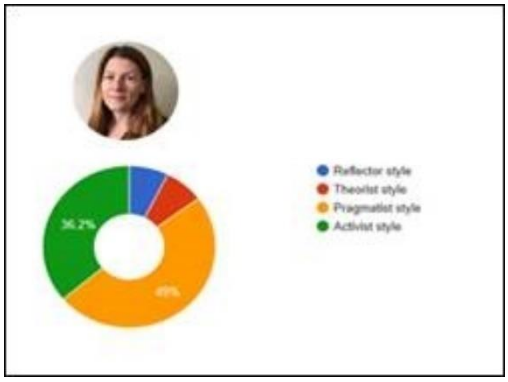
don't stop, keep going

Do not be afraid to explore options that might not sort of first come to mind and be the most obvious

For the love of God, ask for help more

Be prepared to suffer. I think she would still go down the same route, it’ll just be easier to cope with it

Appendix 7: Rachel's learning Styles. Adapted from Honey & Mumford 1986



Appendix 8: Rachel's Clifton Strengths

GALLUP® CliftonStrengths®

rachel Scully

SURVEY COMPLETION DATE: 08-07-2020

Depending on the order of your themes and how you responded to the assessment, some of your themes may share identical insight statements. If this occurs, the lower ranked theme will not display insight statements to avoid duplication on your report.

Your Top 5 Themes

1. Woo
2. Individualization
3. Strategic
4. Futuristic
5. Communication

Appendix 9: Word count

Exec summary	**(461)**
Introduction	**1702**
Literature review	**3030**
Methodology	**1666**
Data Analysis	**3266**
Discussion	**1718**
Recommendations	**1661**
Total word count	**13043**
Reflection	**3317**