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**Understanding the complexities of supporting children's
career aspirations and preparedness for the changing
world of work**

by

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Philosophy

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Declaration

I declare that the thesis has been composed by myself and that the work has not be submitted for any other degree or professional qualification. I confirm that the work submitted is my own, except where work which has formed part of jointly authored publications has been included. My contribution and those of the other authors to this work have been explicitly indicated below. I confirm that appropriate credit has been given within this thesis where reference has been made to the work of others.

The work presented in Chapter 3 was previously published in the International Journal for Educational and Vocational Guidance as “Primary and secondary school students’ career aspirations and job automation-related risks” by Stephen Sowa (student and author of this declaration), Julie Smith (supervisor), and Andrew Manches (supervisor). All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Stephen Sowa. The first draft of the manuscript was written by Stephen Sowa and all authors commented on the previous versions of the manuscript. All authors read and approved the final manuscript.

The work presented in Chapter 4 was previously published in the International Journal for Educational and Vocational Guidance as “Supporting children’s career aspirations under changing career conditions: a systematic review of intervention approaches” by Stephen Sowa (student and author of this declaration), Jinhuan Xia (postgraduate student), Julie Smith (supervisor), and Andrew Manches (supervisor). Stephen Sowa, Julie Smith, and Andrew Manches contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Stephen Sowa, with an independent literature screening completed by

Jinhuan Xia. The first draft of the manuscript was written by Stephen Sowa, while Andrew Manches and Julie Smith commented on previous versions of the manuscript. All authors read and approved the final manuscript. This study was reproduced with permission from Springer Nature.

Abstract

Aspiring to and preparing for a career is becoming an increasingly complex activity for children and adolescents. A young person entering the job market is now more likely to experience multiple career transitions. Recent technological advances are making many routine and some non-routine jobs more susceptible to automation, as well as changing the skill and task requirements within occupations. These changing career conditions are raising complexities for those who support children's and adolescents' career aspirations and preparedness. Career theories and interventions incorporating person-occupation matching approaches may increasingly encounter problems as it may become more difficult to explore rapidly evolving occupational requirements with young people and achieve good-fitting or sustained matches between their career aspirations/choices and future job opportunities. Possible mismatches could mean that more young people experience unemployment and/or various opportunity costs from pursuing or failing to adequately prepare for careers affected by automation. To contribute to an enhanced understanding of these problems, this thesis investigated the complexities of supporting children's and adolescents' career aspirations and preparedness for the changing world of work.

To understand different aspects of the problem, this thesis reports three consecutive and interrelated studies carried out using a mixed methods design. These studies were conducted to address the following overarching research question: what are the complexities of supporting children's career aspirations and preparedness for automation and job change? The research studies were informed by Social Cognitive Career Theory. First, to estimate the automation-related career risks different groups of school students may encounter over the coming decades, an analysis was conducted using large-scale survey data covering primary and

secondary school students' career aspirations and probability statistics on job automation. Study results revealed that adolescents, male students, lower-income groups, and students' parental occupation were associated with a greater likelihood of aspiring to an occupation at higher risk of automation.

While the results from Study One highlighted possible automation-related risks for school children and different subgroups, these risks are potentially nuanced, affecting some higher status and non-routine occupations as well as routine roles. Due to this emerging complexity, it was important to review how recent career aspiration interventions have approached the changing career conditions to critically evaluate a range of possible approaches to the problem. The second study comprised of a systematic review of career aspiration intervention studies involving children (aged 5-18) to gain insights and identify gaps in how recent intervention approaches have/have not addressed job change. Review findings showed that the interventions often focused on select demographic groups and job sectors, with STEM occupations, females, and adolescents targeted more frequently. It was also shown that the intervention objectives and learning content largely did not address changes within occupations or job markets. Because of the limited approaches to addressing job change identified in Study Two, along with the automation-related career risks estimated in Study One, there was reason to explore how a contemporary career education provision could address automation and job change with children.

Considering the context-specific complexities involved in supporting children's preparedness for automation and job change, it was important to examine the perspectives of stakeholders who contribute to children's career education to reveal possible conceptual issues and the practical opportunities and challenges they

encounter. Focusing on the Scottish career education system, a case study was conducted using a thematic analysis of career documentation, a focus group, and interviews with career policymakers, practitioners, and a sample of primary and secondary schoolteachers. Findings revealed that the career education stakeholders conceptualised automation as creating new occupations rather than resulting in the mass displacement of jobs. However, despite recognising that specific job types were becoming more susceptible to automation and that different groups of children tend to aspire to certain types of occupations, stakeholders did not infer that automation may contribute to differential career impacts across groups. Several practical challenges were raised by stakeholders, including managing some children's anxiety due to future career uncertainty.

Consistent with insights from Study Two, Study Three findings showed stakeholders focused on general career skills and adaptability without also exploring the reasons and principles underlying automation and job change. Fostering this meta understanding of job change could aid young people in their career preparedness and decision making by enabling them to discern likely changes to occupations and job markets. After synthesising findings from the three studies, recommendations for advancing career theory and practice were provided. A key contribution of this research was highlighting potential limitations of aspiration-occupation matching theories and interventions by identifying automation-related career risks and supplementary approaches to address the nuanced changes within occupations and job markets. In sum, this thesis revealed how automation and job change may serve as both an environmental barrier and a potential source of inspiration for children as they pursue and prepare for their future careers.

Lay Summary

Children's career aspirations begin forming in early childhood. By mid-adolescence, they are more strongly predictive of their future occupational attainments. However, the process of developing an informed career aspiration and preparing for a future occupation is becoming increasingly difficult for children and adolescents. It is now more common for a young person to experience an unplanned career change.

Recent developments in new digital technologies have been predicted to change task and skill requirements in many occupations, create new jobs, and displace some present-day occupations across various sectors. Due to these rapidly changing job opportunities and requirements, it is becoming increasingly complex for career theories and provisions to facilitate good-fitting or sustained matches between children's personal attributes and their career goals with future job opportunities. To investigate these emerging problems, this thesis is made up of three successive and interrelated studies. These studies were conducted to address the following overarching research question: what are the complexities of supporting children's career aspirations and preparedness for automation and job change?

The first study set out to estimate the career risks different groups of school students may face over the coming decades by pursuing occupations at risk of automation. This involved an analysis using data on primary and secondary school students' career aspirations and probability statistics on job automation. Results indicated that adolescents, male students, lower-income groups, and students' parental occupation were associated with a greater likelihood of aspiring to an occupation at higher risk of automation. Building on these results, a review of career aspiration intervention studies involving children was carried out to critically examine the ways in which recent interventions are addressing the changing conditions underlying careers. This

second study revealed insights and identified gaps in how recent intervention approaches have/have not addressed job change and the risks associated with automation. Findings from the review suggested that recent interventions have often focused on STEM careers, females, and adolescents. Yet, the objectives and content used in these interventions have largely not addressed changes within occupations or job markets, as well as the emerging career risks affecting different groups.

Because of the limited intervention approaches addressing job change identified in Study Two, together with the automation-related career risks estimated in Study One, there was reason to explore how a contemporary career education provision could address automation and job change with children. Study Three set out to examine the perspectives of stakeholders who contribute to children's career education. This was done to reveal possible conceptual issues and the practical opportunities and challenges they face in supporting children's preparedness for automation and job change. Focusing on the Scottish career education system, this case study included a review of career documents, a focus group, and interviews with career policymakers, practitioners, and schoolteachers. Findings revealed that career policymakers and practitioners understood new technologies as likely to create new job opportunities rather than leading to large-scale job losses. While stakeholders recognised that specific job types could be at greater risk of automation and that different groups of children tend to pursue certain types of occupations, they did not conclude that job automation could contribute to varying career impacts across groups. Various practical challenges were also reported by stakeholders, including some children experiencing anxiety due to future career uncertainty.

Consistent with insights from Study Two, Study Three findings showed stakeholders focused on general career skills and adaptability without also exploring the reasons and principles underlying automation and job change. Fostering this meta understanding of job change could aid young people in their career preparedness and decision making by enabling them to deduce likely changes to occupations and job markets. To conclude, findings from the three studies were brought together and several recommendations for improving career theory and practice were provided. A key contribution of this research was to highlight potential limitations of aspiration-occupation matching theories and interventions by identifying automation-related career risks and supplementary approaches to address the nuanced changes within occupations and job markets. Overall, this thesis revealed how automation and job change could serve as both a barrier and a potential source of inspiration for children as they aspire to and prepare for their future careers.

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1.0 Introduction

1.1 Chapter overview

This chapter explains the background to this thesis and details the research problem and purpose to which it is concerned. The chapter begins with an introduction to the recent changes underway in career pathways, job markets, and occupations. It is explained how the development of new technologies may significantly contribute to future job change. Following this the problem of supporting young people's career aspirations and preparedness within the context of increasing automation and job change is outlined. Subsequently, a description is provided of how the research project emerged and evolved. To conclude the overarching research aims and general methodological approach are discussed, along with an overview of the chapters to follow.

1.2 The growing complexity of preparing for the future

Preparing for the future has become an increasingly complex activity in contemporary societies. People and organisations are facing considerable uncertainty due to rapid changes in work environments, technology, and social affairs (Hodder, 2020; Schwab, 2017). As the Covid-19 virus rapidly spread across the world resulting in substantial loss of life, impacts on mental and physical health, and disruption to economies and workers, people and organisations had to find ways to adapt (Hodder, 2020). Trends in remote work, e-commerce, and automation accelerated during the pandemic, with an increased proportion of workers potentially needing to transition to new occupations (Lund et al., 2021). Climate change presents many additional future planning challenges for governments, workers, and

civil society, including implications for human health, infrastructure, labour, and jobs (Day et al., 2019; Paavola, 2017).

In the world of work, as with other domains, change is not a new phenomenon. Over the centuries workplaces and employment patterns have historically changed as new forms of organising societies have emerged and technology has advanced (Autor, 2015). However, the speed of recent change, both technologically and within job markets, is noticeably distinct from previous eras (Frey & Osborne, 2017; Schwab, 2017; Scully-Russ & Torraco, 2020). The ramifications of recent technological change could be far reaching, spanning workplaces, social and political organisations, education, entertainment, and forms of communication (Brynjolfsson & McAfee, 2014; Schwab, 2017). For example, new natural language-based artificial intelligence technologies such as ChatGPT not only have the potential to significantly affect many jobs and tasks within occupations (e.g., coding, marketing), they could also affect the instruction and assessment approaches used in education provisions (Chui et al., 2022).

The accelerating changes in technology and the world of work are raising implications for multiple institutions that, to varying extents, support children and adults in preparing for their futures. Schools and universities, as well as social and career services, have and continue to support people in developing knowledge, skills, social resources, and/or goals that relate to the world of work and other spheres of life (Kliebard, 1999; Lent & Brown, 2020; OECD, 2019). However, as work and life conditions rapidly change, facilitating or sustaining a close alignment between a person's attributes and particular future conditions becomes increasingly challenging. This future-related complexity is particularly consequential in the field of career theory and practice. This is because recent technological and work-related

changes are presenting problems for foundational career concepts and approaches based on achieving good-fitting matches between persons and their future occupations (Lent & Brown, 2020). Because of the significant implications of future technological and work-related change for career theory and practice (Hirschi, 2018), this thesis focused primarily on emerging complexities within the domain of careers rather than those concerning other fields of social inquiry.

1.3 Careers and future work-related change

Though career theories and approaches have advanced substantially over the last century, the historic three-step process articulated by Parsons (1909) remains a common part of contemporary professional approaches to facilitate informed career choice-making (Lent, 2013a; Lent & Brown, 2020). This process involves the rationale development of a career goal or choice by means of promoting (i) self-reflection (i.e., reflecting on personal values, interests, and skillsets), (ii) exploring potentially relevant career options and learning about their requirements and offerings, and (iii) comparing or matching one's self-concept to prospective career options (Parsons, 1909). Embedded in this process is the assumption that there are relatively stable features of persons and work environments that can be rationally understood, compared, and matched (Lent, 2013a; Lent & Brown, 2020).

The use of this process during the last century was relatively unproblematic due to the comparative stability of career options and people's more predictable career trajectories (Savickas, 2000; Strong, 1953; Whitney, 1969). However, as accelerated change occurs across job markets and within occupations a straightforward comparison or stable match between a person and a good-fitting occupation is becoming increasingly difficult to achieve (Lent & Brown, 2020; van Vianen et al., 2009). So too is the task of learning about and preparing for occupational skill and

task requirements which are rapidly evolving due to automation (Colombo et al., 2019; Ubalde & Alarcón, 2020). The increased possibility for misalignments between persons (i.e., their attributes and career goals/choices) and future job opportunities could mean that people experience job loss or unemployment in some cases, and/or various opportunity costs (e.g., financial loss, skill gaps) from pursuing or failing to adequately prepare for careers affected by automation (Hoff et al., 2022; Lent, 2018).

Current and forthcoming generations of young people as future career choice makers and workers could be significantly impacted by this accelerating job change. As more wide-ranging job automation is predicted over the coming decades (Bughin et al., 2018; Kumar et al., 2019), potentially impacting more routine as well as some non-routine occupations (PwC, 2018; Schwab, 2017), unprecedented future job changes may coincide with contemporary children's important educational and career decision making points. Given the potentially significant yet little-known ramifications of automation and job change for children's and adolescents' career aspirations and preparedness (Hoff et al., 2022; Lent, 2018), this thesis set out to investigate the complexities of supporting children's career aspirations and preparedness for the rapidly changing world of work. To build a case for this line of inquiry, the next sections describe the recent changes underway in career pathways, job markets, and occupations. This is followed by a discussion of how accelerating automation and job change could raise new issues for career theory, intervention approaches, and stakeholders' support for children's career development.

1.3.1 Changing career pathways and job markets

Over recent decades it has become more common for a person's career path to comprise of multiple transitions (Savickas, 2000; Sullivan & Al Ariss, 2021).

Research comparing business graduates who graduated in the 1990s with those who graduated in the 1970s found that the 1990s cohort made significantly more career moves on average than their 1970s counterparts within a 15 year period after graduation (Chudzikowski, 2012). Several types of career transitions are now being observed more frequently. Research indicates that people are making more transitions across the “boundaries of occupations, industries, organisations, countries, and the labour market” (Sullivan & Al Ariss, 2021, p. 1). Conversely, it has now become less common for individuals entering as entry-level workers to ascend the career ladder within organisations (Krieshok et al., 2009; Savickas, 2000; Savickas, 2015). This development has particularly important career consequences for young people as they more often obtain entry-level jobs (OECD, 2018).

Alongside the rise of multiple career transitions there have also been significant changes in job markets over recent decades. These changes have modified the range and types of job opportunities from which career choice makers can select. Since the 1980s there have been substantial reductions in manufacturing employment and the elimination of various other routine occupations (Charles et al., 2013; Jaimovich & Siu, 2012). More broadly, there has been an increased proportion of high-skilled jobs, reductions in middle-income/skilled jobs, and increased proportions of low-income/skilled jobs particularly within the service sector (Autor & Dorn, 2013; Mandelman & Zlate, 2022). Though a range of different factors have influenced these trends across many Western countries, including the offshoring of jobs and changing immigration patterns (Salvatori, 2018), job automation has been an important contributor (Autor, 2015). Now, a new phase in job automation has been predicted to bring about a distinctive set of job changes.

1.3.2 Technological advances and a new phase of job automation

Much of the job automation taking place over past few decades has involved jobs and tasks classified as routine. Routine manual labour or cognitive tasks are job tasks defined as those that follow explicit rules or procedures (Autor et al., 2003).

Whereas non-routine cognitive or manual labour tasks are job tasks which cannot be easily defined using explicit rules. Because of this they are more difficult to develop algorithmic solutions for and have therefore been less susceptible to automation.

However, recent technological advances across a range of fields have led some to argue that increasing numbers of traditionally non-routine tasks, in addition to more routine tasks, could be converted into well-defined problems which could be subject to automation (Brynjolfsson & McAfee, 2014; Frey & Osborne, 2017; Schwab, 2017).

Technological advances in fields spanning the engineering sciences and mobile robotics, together with those concerning machine learning and artificial intelligence, have thus widened the potential scope of automation (Frey & Osborne, 2017).

Some of the most prominent emerging technologies include: autonomous vehicles and drones; 3D-printing; advanced materials (e.g., nano technologies); synthetic biology; the Internet of Things; Blockchain; cloud technology and big data; quantum computing; and virtual and augmented reality (Brynjolfsson & McAfee, 2014; Kumar et al., 2019; Schwab, 2017). The realisation of these technologies could soon result in some traditionally non-routine tasks and jobs becoming highly susceptible to automation, such as: the transportation of goods and people using driverless vehicles; pre-trial research tasks completed using computer-based language analysis of legal briefs; and cancer treatment diagnostics (Brynjolfsson & McAfee, 2014).

Occupations at higher risk of automation are thought to include manual labour intensive roles in industry and manufacturing, many low-skilled and low-wage occupations across various sectors, and some traditionally high-status non-routine occupations (e.g., accountant, financial adviser) (Frey & Osborne, 2017; World Economic Forum, 2020). Whereas occupations involving tasks requiring higher levels of creativity, social intelligence, and perception and manipulation in unstructured environments are thought to be at lower risk of automation due to persisting engineering bottlenecks associated with performing these tasks (Frey & Osborne, 2017).

The exact number of jobs displaced and created by future job automation remains subject to ongoing debate due to the many mediating socio-economic factors (Arntz et al., 2017; Autor, 2015). Yet because automation may increasingly impact the composition of job markets as well as the skill and task requirements within occupations in new and nuanced ways (Frey & Osborne, 2017; Kipper et al., 2021), there are important consequences for children and adults and those who support them in preparing for and/or managing their careers (Hirschi, 2018; Lent, 2018). The following section explains some of these possible consequences.

1.4 Possible consequences of future job change for people's careers

Forming a career aspiration, developing career preparedness capacities and resources, and making informed career-related decisions are important and sometimes difficult activities in people's career journeys (Gottfredson, 2002; Lent & Brown, 2020; Super et al., 1996). Such activities could become more complex in the context of increasing automation and job change (Lent, 2018). First, the increased possibility of experiencing multiple career transitions may mean that some people's initial or preferred career goals and choices misalign with their later occupational

attainments. Further misalignments between people's career aspirations and their actual occupational attainments could also result from the automation of increasing numbers of routine and some non-routine occupations. The consequences of this change could include more people facing job loss, difficulties in entering or re-entering the job market, and possible psychological and financial costs from unfulfilled career plans (Hoff et al., 2022; Lent, 2018; Lent & Brown, 2020).

For future workers and career choice makers it may also become more challenging to comprehend the range of suitable or realistic career options to make informed decisions as technology increasingly displaces and creates new occupations (Lent, 2018). Rapidly changing skill requirements and occupational tasks will similarly make it more difficult for people to purposefully develop job-specific skills and prepare for their preferred career(s). This may include, for example, the growing prominence of social tasks in technology roles and uncertainty regarding the future value of coding skills (Bughin et al., 2018; Colombo et al., 2019).

The prospect of increasing and differential automation across job sectors has the potential to increase and/or change occupational attainment risks for different groups (e.g., gender, age, socio-economic groups, etc.). For instance, with low-paid and low-skilled roles possibly being more susceptible to automation, lower socio-economic groups, who disproportionately hold such occupations, could face additional occupational attainment issues (le Roux, 2018; Mann et al., 2020). Young people as future workers may similarly encounter greater career difficulties if automated entry level and low-skilled positions are not sufficiently supplemented by alternative jobs or other initiatives (Mann et al., 2020; OECD, 2018).

1.4.1 Implications for children's career aspirations and preparedness

Because significant automation-related changes to labour markets are predicted to take at least a decade or two to appreciably manifest (Frey & Osborne, 2017; PwC, 2018), present and forthcoming generations of children and adolescents could be most significantly impacted as changes may coincide with their important educational and career decision making milestones. Considering the above-mentioned negative career consequences and opportunity costs possibly resulting from automation and job change, support for children's career aspirations and preparedness for the changing world of work could be important for several reasons.

Children begin thinking about and developing aspirations for their future careers from an early age. Studies indicate children as young as five (and plausible younger) can express career aspirations (Lee, 2012). As children mature into adolescence their career aspirations become more stable and they typically narrow their range of career options using various social and personal criteria (Gottfredson, 2002; Helwig, 2001; Schmitt-Wilson & Welsh, 2012). During adolescence young people's career aspirations, which are strong predictors of their future career choices and attainments (Schoon, 2001), may become less amenable to change (Archer, DeWitt, & Dillon, 2014). Providing career support prior to and during adolescence could therefore be potentially important. This support could inform children and keep their options open to a broader range of future job opportunities and new occupational skill requirements shaped by automation, along with developing career preparedness or adaptability resources to navigate possible career change (Ginevra & Nota, 2018; Hoff et al., 2022).

Yet, while there is a growing body of literature documenting interventions and provisions in support of children's general career development (Hughes et al., 2016;

Kashefpakdel et al., 2018), at present little is known about the theoretical and practical implications of supporting children's and adolescents' career aspirations and preparedness for automation and job change (Hoff et al., 2022; Lent, 2018; Watson & McMahon, 2022). In response to this research gap the following section explains why the theoretical, empirical, and practical aspects of the research problem were important to examine in this thesis.

1.5 Complexities of supporting children's career aspirations and preparedness

1.5.1 Empirical and practical problems

A relevant starting point in understanding the complexities associated with children's career aspirations and preparedness for a rapidly changing world of work is to first identify those in possible need of support. Because automation and job change may impact certain types of occupations more than others (Frey & Osborne, 2017), and since certain groups of young people may be more likely to pursue and attain specific job types (Gore et al., 2017), various groups of children and adolescents could encounter disparate automation-related career risks. Thus, by combining a model of job automation with children's and adolescents' career aspirations as predictors of their future occupational pursuits and attainments (Schoon, 2001), it is possible to estimate differences in the automation-related career risks various groups of young people could encounter. This research was undertaken in the first study of this thesis. The study results subsequently informed the two studies that followed.

Next, rather than proceeding to conduct an intervention to address the identified career risks, given the uncertain benefits and drawbacks of supporting children's

career aspirations under changing career conditions, an alternative line of enquiry was pursued. In conducting career interventions, including support for children's and adolescents' career aspirations, it may be increasingly important to use approaches that address changes within occupations and the rapidly evolving job opportunities or risks resulting from automation. By reviewing recent career aspiration interventions with children (aged 5-18), it is possible to critically examine how the intervention approaches have/have not addressed automation and job change through their objectives, target groups, and content/activities. This could reveal valuable insights and identify gaps in how recent intervention approaches have addressed job change and the possible risks associated with automation. The second study in this thesis involved a review of this kind.

To further this line of enquiry a third study was conducted. As support for children's career aspirations and preparedness can come from different institutions and stakeholders, including policymakers, career practitioners, and teachers (Ali et al., 2012; Taveira et al., 2017), exploring stakeholders' perspectives can help to reveal the challenges and opportunities they face in supporting children's preparedness for automation and job change. By examining stakeholders' conceptions of automation and job change, along with the practical challenges and opportunities they encounter in implementing career education provisions with children, relevant findings could be obtained to elucidate the complexities of supporting children's career preparedness for the changing world of work.

1.5.2 Theoretical problems

While studying these complexities related issues in career theory could also be examined. Due to the instability now present in jobs and the increased possibility of a person experiencing multiple career changes, some researchers have suggested

that theories and approaches incorporating a process to align or match choice makers to good-fitting occupations are no longer viable (van Vianen et al., 2009). Rather than prioritising good-fitting choice making, some argue that the core concept of career theory should focus on career adaptability as a set of resources to manage change and uncertainty (van Vianen et al., 2009). It is suggested this shift could promote people's flexibility to navigate ongoing workplace change, cope with unexpected career events, build resilience, and develop a propensity to explore various possible selves and future work possibilities (Savickas, 2011, 2013).

In contrast, others have suggested that while accelerated changes to workplaces and careers are occurring, and there is a growing need to promote adaptability, this does not invalidate the benefits of helping choice makers find (as near as possible) a compatibility between their personal traits and an occupation in which they may perform successfully (Lent, 2013a; Lent & Brown, 2020). Theories centred around career adaptability may also have their own set of problems. One of these challenges concerns the difficulty people typically face in speedily developing new skills and proclivities to shift from one career pathway to another potentially disparate pathway (Lent, 2013a). Another challenge relates to a person's tendency to circumscribe various career options in childhood using certain personal and social criteria (Gottfredson, 2002; Helwig, 2001). Specific career options become more appealing or are perceived as more realistic relative to others, leading to a narrowing of career options. This in turn means there is a reduced possibility for a person to shift into different career paths in which they possess insufficient interest, self-efficacy beliefs, and outcome expectations (Lent, 2013a).

A benefit of theories and approaches incorporating a person-occupation alignment or matching process is that they can provide a basis for predicting career trajectories

and thus help to identify those who may encounter greater career risks (Tang, 2019). Such theories can also inform explanations and intervention approaches to help children and adults find or pursue specific career options they are likely to be satisfied with and/or to achieve wider social goals (e.g., reducing group disparities in occupational attainments) (Lent, 2013a; Piesch et al., 2020). For the purposes of carrying out the above-mentioned studies, it was beneficial to draw on and critically examine a leading theory that incorporates both perspectives. Social Cognitive Career Theory was used because it retains a person-occupation alignment focus while also specifying environmental supports and barriers, such as changing job markets, that affect people's career aspirations and preparedness (Lent, 2013a; Lent & Brown, 2020). Through the research undertaken in the three studies and a subsequent synthesis of findings, contributions were made to inform the development of the theory. A detailed discussion of Social Cognitive Career Theory is provided in the next chapter.

1.6 Overarching research aim

Accelerating automation and job change are likely to raise new risks related to children's career aspirations and preparedness. Yet, in supporting children's career aspirations and preparedness, stakeholders and commonly used intervention approaches may not adequately address the emerging complexities of job change and the nuanced risks associated with automation. Because little is currently known about these complexities, it is important to investigate what these are in order to develop plans for addressing them. The aim of this thesis was to contribute to an understanding of the complexities of supporting children's career aspirations and preparedness for the changing world of work. En route to achieving this aim, the following overarching research question was addressed:

What are the complexities of supporting children's career aspirations and preparedness for automation and job change?

To answer this overarching research question, three interconnected studies were carried out to address different aspects of the research problem using a mixed-methods design. In the final chapter a synthesis of the findings from the three studies was conducted and implications for career theory and practice were discussed. By investigating the career-related complexities associated with automation and job change, this research provided valuable insights for researchers in advancing career theory, as well as for career practitioners and other stakeholders involved in supporting children's career aspirations and preparedness. Before moving on to discuss the methodological approach and the interconnections between the three studies, the next section provides a summary of how this thesis emerged and evolved over time.

1.7 Development of the thesis

During the early planning stages for this thesis, I encountered a new body of literature that would set me off on an exciting intellectual journey. I came across various reports and academic publications discussing significant advances in new digital technologies, the theorised consequences of these developments for the world of work, along with possible implications for how people are educated. This curiosity took me down a few avenues. One of these involved reading literature discussing the need for revised educational purposes and approaches in response to the increasing capacity of machines to perform a growing number of routine as well as some non-routine job tasks. Particular emphasis is placed on the development of domain-general skills, such as metacognition, problem-solving, creativity, and collaboration. In other words, the capacities which are less well defined and

reproduceable in terms of algorithms, but which human beings may continue to exhibit unparalleled mastery over.

Through my engagement with this material my thinking was provoked to reflect on whether domain-specific knowledge may still have an important role to play in education and skill development for the future world of work. This led me to read academic material arguing for domain-specific knowledge as a necessary condition to achieve specialised expertise and to manifest domain-general skills. After considering ways to examine hypotheses which could distinguish between the benefits of teaching domain-general skills vis-à-vis domain-specific knowledge to meet future work demands, I came to a pragmatic decision to pursue a different research path.

Upon reviewing predictions for the occupations most likely to be subject to automation over the coming decades, I contemplated whether children's career goals could be misaligning with these projections and the possible ramifications of this. To investigate this line of enquiry further, I reached out to a UK-based organisation to obtain a large, anonymised survey dataset on school students' career aspirations and other demographic variables. By bringing this dataset together with probability statistics on job automation, it became clear that there was a possibility to conduct a secondary data analysis to estimate possible automation-related career risks across different groups of school students. This career risk analysis was further developed and refined to become the first study in this thesis.

To build on the first study I started to develop plans to work with schools and students to explore the career development benefits of learning about automation and job change. However, around this point in time the Covid-19 pandemic started.

Subsequent attempts to contact local schools in Scotland between 2020-2021 to organise online or in-person design-based research activities proved unsuccessful. Despite the school access issues, I was able to quickly adapt to continue my research through desk-based and online methods. Consequently, I conceived of a new sequence of interconnected studies to build on Study One and develop a cohesive argument to address the overarching research question. These studies are described in more detail in the following sections.

1.8 General Methodology

1.8.1 Philosophical assumptions

Beginning with an axiological assumption, this research proceeded on the informed basis that there was value in investigating the complexities of supporting children's career aspirations and preparedness for the changing world of work. By studying and unpacking these complexities it was supposed that various stakeholders could be in a better position to weigh the benefits and drawbacks of supporting children to prepare for automation and job change. With this understanding practitioners and researchers may also be better placed to pursue further lines of enquiry to aid career research and practice with children.

To guide this research the philosophical tradition of pragmatism was drawn on. Rather than holding to a particular view about the nature of reality (e.g., mind-dependent or mind-independent), pragmatism understands human thought and language as tools for prediction, solving problems, and guiding action (Creswell & Creswell, 2017). In this regard pragmatism is not concerned with whether empirically derived propositions correspond to states of affairs, but instead whether empirical findings contribute to an understanding of the research problem or help to ascertain what works for a given course of action (Legg & Hookway, 2021). This philosophy is

suited to the purpose of this research as it was concerned, in part, with making predictions about children's career pursuits to understand the possible automation-related career risks they may face. In other words, this research was not trying to demonstrate that these career risks represent an actually obtaining future state of affairs, but rather that they contribute to an understanding of the complexities of supporting children's career aspirations within the context of a rapidly changing world of work.

A pragmatic perspective recognises that research takes place in unique socio-economic contexts and that the researcher should be aware of relevant contextual influences when planning for and addressing the research problem (Creswell & Creswell, 2017). Because this research took place in a high-income country at a moment in time when heightened media attention was being directed at new digital technologies (e.g., ChatGPT), it was important to consider how such contextual factors could influence the research project. This reflective process was undertaken and reported on in chapters 5 and 6. Since pragmatism focuses on the research problem rather than the philosophical assumptions underlying different methods, a mixture of methods can be used to collate useful insights about the problem (Biesta, 2010). In this research this meant using quantitative methods, qualitative methods, and both methods concurrently based on the specific study questions being addressed. Before moving on to discuss this mixed methods design, the following section explains how the overarching research problem was broken down into distinct parts.

1.8.2 Compartmentalising the research problem

To simplify the multifaceted problem of investigating the complexities of supporting children's career aspirations and preparedness for automation and job change, it

was useful to break the research problem down into distinctive parts. Three sequential studies were completed to analyse different features of the problem. In close accord with the stages specified in Osland et al. (2006) model of problem-solving, Study One corresponded to the problem/risk analysis stage, Study Two corresponded to the solution/intervention approach analysis stage, and Study Three corresponded to the implementation analysis stage. Findings from the three studies were synthesised in the final chapter to explain the theoretical and practical complexities pertinent to the research problem. This sequential research process is illustrated in Figure 1 below.

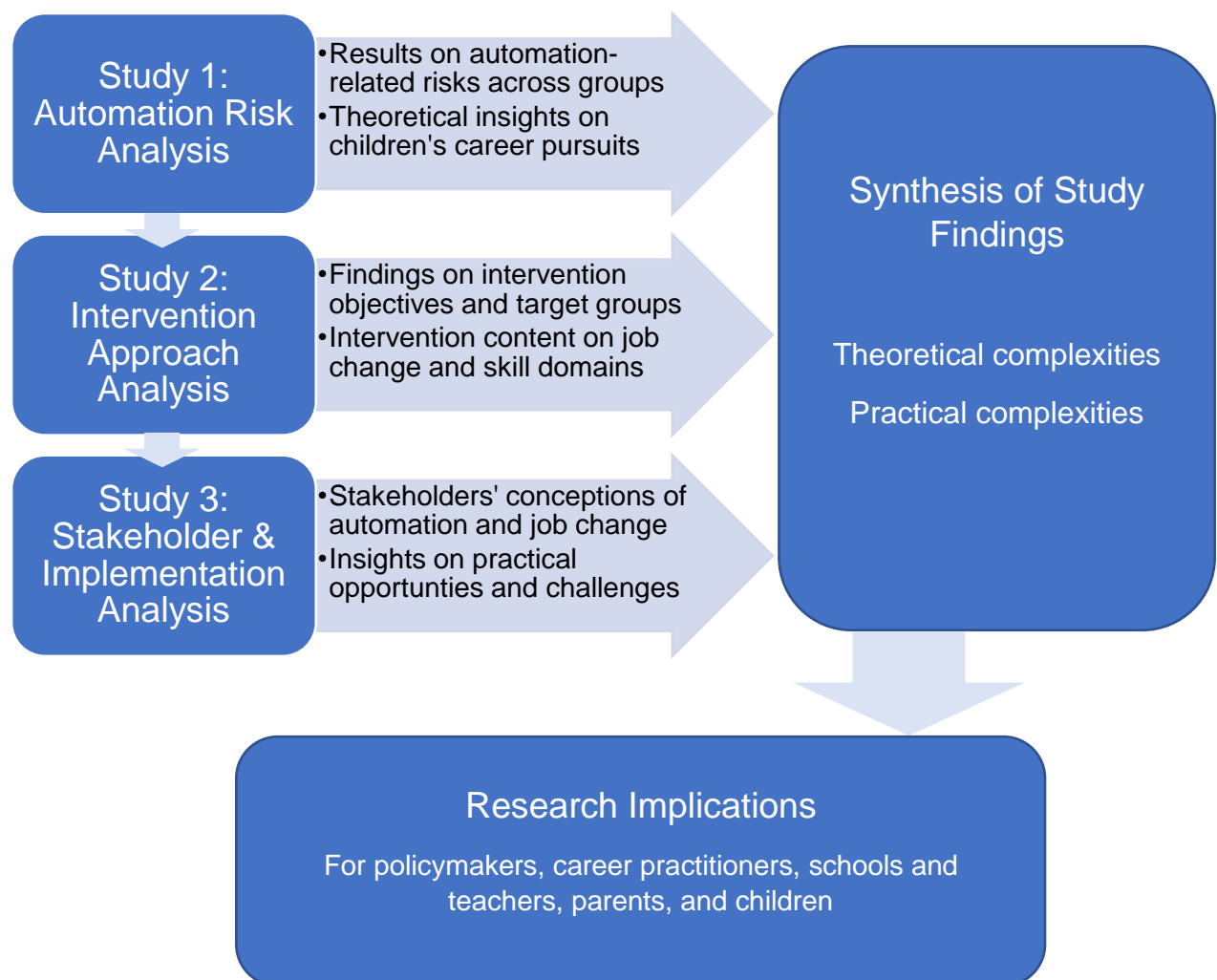


Figure 1 Multi-stage approach to addressing the research problem

The first stage of this thesis comprised of a study to identify and explain the automation-related career risks school students and various subgroups may encounter over the coming decades in pursuing occupations at risk of automation. Results indicated that male students, lower socio-economic groups, older age groups, and students' parental occupation were associated with a greater likelihood of aspiring to high-risk occupations. Building on the results of the first study, the second stage of the thesis reviewed the ways in which recent career aspiration intervention approaches with children (aged 5-18) have/have not addressed the changing career conditions, including the risks and opportunities associated with job automation. Findings from the systematic review suggested that recent interventions have focused on a narrow range of demographic groups and job sectors. The intervention objectives and content generally did not cover changes within occupations or job markets.

To advance enquiry based on the gaps identified in the review a third study was conducted. This study examined the contextual complexities and stakeholders' perspectives of supporting children's preparedness for automation and job change. Based on a case study of the contemporary Scottish career education system, the study gathered insights from public documentation, policymakers, career practitioners, and schoolteachers. Findings revealed certain conceptual inconsistencies, practical challenges in supporting children's learning about job change, and unaddressed opportunities to extend children's career learning beyond general career skills to also explore the reasons and principles underlying automation and job change. The final stage of the thesis involved a synthesis of the separate study findings to address the overarching research question. Contributions to career theory and practice were discussed, including insights for advancing Social

Cognitive Career Theory. It was shown how automation and job change could function as both an environmental barrier and a source of inspiration for children's career pursuits and preparedness for the future world of work. Implications for career researchers and various stakeholders were subsequently presented.

1.8.3 Mixed methods research design

To address the three components of the research problem a mixed methods design was used. This design affords the use of both qualitative and quantitative approaches across a multi-study research project and/or the mixing of both approaches within a single investigation (Creswell & Creswell, 2017; Hesse-Biber & Johnson, 2015). An advantage of using a mixed methods design can include minimising the weaknesses present in one methodological approach through the addition of a separate approach possessing complementary strengths (Tashakkori & Teddlie, 2015). Qualitative and quantitative research methods can be used sequentially to link one study to another, as well as concurrently within the same study depending on the overarching research goal and specific research questions being addressed (Biesta, 2010; Tashakkori & Teddlie, 2015).

To achieve the overarching research aim, this thesis used a sequential mixed methods design. Study two also employed quantitative and qualitative research approaches concurrently. It was important to use these differing methods sequentially as well as concurrently for reasons of study development and complementarity respectively (Biesta, 2010; Tashakkori & Teddlie, 2015). The first study employed a quantitative analysis of large-scale survey data covering school students' career aspirations and probability statistics on job automation. A quantitative approach was used to generalise across the school student population

and to obtain reliable estimates of automation-related risk differences across groups. This broad analysis provided a basis from which to develop the second study.

Study Two included a review of recent career aspiration intervention studies with children to critically examine how the intervention approaches have/have not addressed job change and the risks associated with automation. The systematic review incorporated qualitative data in the form of textual descriptions to complement or elaborate on descriptive statistics covering the intervention objectives, target groups, and learning content. The aggregation of qualitative and quantitative data helped to ensure that a more comprehensive and reliable set of findings could be collated to infer sound conclusions about the recent focus and approaches used in career aspiration interventions. The insights and identified gaps from the review informed the development of the third study.

To explore the implementation complexities and stakeholders' perspectives of supporting children's preparedness for automation and job change, a case study was undertaken of the Scottish career education system. This study involved aggregating and triangulating across qualitative data obtained from a thematic analysis of career documentation, a focus group, and interviews with career policymakers, practitioners, and schoolteachers. Collection and analysis of this qualitative data enabled a more in-depth and context-specific understanding of the conceptual and practical complexities of supporting children's preparedness for the changing world of work. In bringing the findings from the three studies together a process of triangulation was carried out to converge separate lines of quantitative and qualitative evidence (Biesta, 2010; Tashakkori & Teddlie, 2015). This process helped to corroborate conclusions about the theoretical and practical issues relevant to the research problem.

1.9 Declaration of ethics

This research and the three studies contained within this thesis were carried out in accordance with the British Educational Research Association (BERA) ethical guidelines. The studies were approved by the Moray House School of Education Ethics Committee. Information is provided on the ethical considerations specific to each study in Chapters 3, 4, and 5. Ethical approval confirmation letters for the studies are available in Appendix A.

1.10 Personal development and knowledge exchange

Through my doctoral studies I have developed academic expertise in areas ranging from children's career development to job automation. By drawing on my expanding knowledge, I have been able to share valuable insights with a range of different audiences. Over the past three years I have disseminated my knowledge through presentations at several academic conferences, talks at public institutions, and via a mentoring programme with local schoolteachers. To engage with the academic community, I presented my research at academic conferences focused on career guidance and education. I have also communicated to the academic community through various written materials, including blog posts and articles published in peer-reviewed journals.

To inform policymaking I have also shared my work at national consultations on the future of Scottish education and talks with policymakers. For instance, I was invited to present some of my research findings at the Scottish Government as part of their labour market and education seminar series for policymakers. To engage with practitioners, I also participated in a mentoring programme which paired scholars with local Scottish schoolteachers to develop their understanding and use of digital technologies in the classroom.

In addition to these professional development activities, I have also worked as a Tutor on several postgraduate and undergraduate courses at the University of Edinburgh. These included postgraduate courses on research philosophy and research methodologies in the social sciences, a course entitled Children and Technology, and two undergraduate courses, including one course titled Understanding and Addressing Global Challenges. The experience I have gained from teaching on these diverse courses has broadened my interdisciplinary knowledge and enriched the ideas I have brought to this thesis. To enhance my teaching practice, I also completed the Edinburgh Teaching Award and was awarded the status of Associate Fellow of the Higher Education Academy.

In May 2022, I also led the planning and delivery of an academic conference for staff and postgraduate students within Moray House School of Education and Sport. The Conference was organised under the theme of managing epistemic and practical uncertainties in research. Recently I was awarded a £6200 grant to lead a research project at the University of Edinburgh entitled the Sustainable Careers Project. This project aims to develop a sustainable career learning intervention to support undergraduate and postgraduate students in exploring how they can contribute to sustainable development through their future careers. The intervention also aims to build students' understanding of how careers can be shaped by new technological developments and socio-economic conditions. In sum, these doctoral experiences have improved my ability to write and communicate with a broad range of audiences, productively challenged my thinking, and enhanced my passion for the exciting world of academia.

1.11 Chapter overviews

In the following chapter research on future job automation will be critically examined in more detail. This included a discussion of the model developed by Frey and Osborne (2017), its limitations, and its potential use for estimating automation-related career risks. Next, the possibility of using children's and adolescents' career aspirations as predictors of their future occupational attainments was discussed. This is followed by an explanation of Social Cognitive Career Theory and a review of studies reporting on various personal and social factors that contribute to the development of children's career aspirations, beliefs, and knowledge. The concluding sections of the chapter explore the emerging possibilities and potential challenges of supporting children's career aspirations and preparedness for automation and job change.

Chapter 3 reports the first study in this thesis. This study set out to estimate the automation-related risks school students and various subgroups could encounter in pursuing their future careers over the coming decades. Chapter 4 reports the second study in this thesis. This comprised of a systematic review of career aspiration intervention studies to gain insights and identify gaps in how recent intervention approaches have/have not addressed the changing conditions underlying careers.

Chapter 5 reports the third study in this thesis. To acquire an understanding of the implementation complexities and stakeholders' perspectives on supporting children's career preparedness for automation and job change, a case study was conducted of the Scottish career education system. The study highlighted various conceptual and practical challenges and opportunities of supporting children's career preparedness for the changing world of work. Chapter 6 synthesised the findings from the three studies as they pertain to the theoretical and practical complexities of the research

problem. Implications for the development of career theory and practice are discussed, as well as recommendations for different stakeholders involved in children's career education.

2.0 Literature Review

2.1 Chapter overview

This chapter begins by critically reviewing literature covering recent changes to job markets, occupational skill requirements, and future job automation. The limitations and benefits of using a model of job automation to estimate automation-related career risks are then explained. Next, the career aspirations of young people are discussed as potential predictors of their career pursuits and attainments in adulthood. After outlining Social Cognitive Career Theory as a guiding theoretical framework, research was examined on the personal and environmental factors shaping children's and adolescents' career aspirations. Subsequent sections of the chapter critically discuss a rationale for supporting children's career aspirations and preparedness, as well as revealing how automation and job change are raising new complexities for career theory and practice with children. To conclude, research questions for the three studies are introduced.

2.2 Recent changes to job markets and occupations

Alongside the increasing prevalence of multiple career transitions (Chudzikowski, 2012; Sullivan & Al Ariss, 2021) there have been significant changes to job markets over recent decades. Since the 1980s there have been substantial reductions in manufacturing jobs and the elimination of various other routine occupations (Charles et al., 2013; Jaimovich & Siu, 2012). In several higher-income countries (e.g., USA and UK) there has also been a proportional increase in high-skilled jobs, a reduction in middle-skilled occupations, and an increased proportion of low-skilled jobs particularly within the service sector (Autor & Dorn, 2013; Mandelman & Zlate, 2022). This increase in low-skilled roles relative to middle-skilled jobs has been theorised to

be the result of manual labour tasks within lower-income service roles being less susceptible to automation due to the higher degree of flexibility and physical adaptability required to perform the tasks (Autor & Dorn, 2013; Autor et al., 2003).

Various researchers have suggested that the increased automation of various routine occupations and tasks has contributed significantly to recent job market trends, such as the automation of the functions of bookkeepers, telephone operators, and cashiers (Bresnahan, 2001; Manyika et al., 2013). Nonetheless, recent changes in job markets are linked to a range of other factors. The offshoring of jobs and changing immigration patterns have also likely contributed to recent changes in labour markets in many Western countries (Autor & Dorn, 2013; Salvatori, 2018). Though the exact contribution of technology to job trends since the 1980s remains subject to ongoing debate (Salvatori, 2018), new and accelerating technological advances have informed recent enquiry into the future trends in job creation and displacement.

Advances in machine learning, artificial intelligence, mobile robotics, and other technical fields have prompted some to postulate that technology could increasingly substitute for human labour across a range of routine as well as some non-routine domains (Brynjolfsson & McAfee, 2014; Frey & Osborne, 2017; Schwab, 2017). These speculations have in turn led to counterarguments. Questioning the likelihood of mass unemployment, several researchers note that similar to historic predictions, the likelihood of mass unemployment in the near future is unlikely to be realised because of underestimates in the new jobs created through gains in productivity and the new occupations branching off automated work (Autor, 2015; Mokyr et al., 2015; Morgan, 2019).

However, some researchers maintain that the expanded scope of technology to perform both routine and some non-routine manual and cognitive tasks means that the impending scale of job automation may well exceed the number of new jobs created by technology (Brynjolfsson & McAfee, 2014; Frey & Osborne, 2017; Schwab, 2017). Following this reasoning it would eventually become very difficult to find new profit-making uses for human labour as technology becomes comparatively more cost effective and efficacious across a sufficiently wide range of work domains. To obtain a clearer insight into the future impact of technology on occupations and job markets, several models of job automation have been developed. The following section examines recent models of job automation, highlighting their value and limitations. Subsequently, the benefits of using one of these models to help predict the automation-related career risks young people may encounter are discussed.

2.3 Predicting future job automation

Studies estimating the scale of future job automation across multiple countries have produced varying estimates. Some of the higher-end estimates have reported around 47%-30% of presently existing jobs as being highly susceptible to automation (Frey & Osborne, 2017; PwC, 2018). Lower-end estimates place the figure at around 9%-14% of jobs (Arntz et al., 2017; OECD, 2018). While these projections vary and they adopt somewhat different methodologies, with some estimating technological adoption time lags, they frequently draw on the model developed by Frey and Osborne (2017). Their model has significantly shaped debates and influenced the field of job automation (with over 12,000 citations on Google Scholar). This research was a pioneering attempt to quantify the susceptibility of presently existing occupations to be automated from a technical feasibility standpoint (i.e., not accounting for socio-economic variables). The model aims to account for the

engineering bottlenecks that could limit the extent of job automation. These bottlenecks refer to difficulties machines could encounter in performing job tasks requiring creativity, social intelligence, and/or perception and manipulation in unstructured environments.

To estimate the probabilities of present-day occupations being subject to automation in the near future (the number of years into the future is unspecified, but the researchers indicate it could be within the next decade or two), the researchers brought together technology experts across a range of fields for a workshop at the University of Oxford. The technology experts engaged in discussions and then assigned probability values (between 0-1) to a sample of 70 occupations out of a larger total of 702 occupations. A probability value of 1 would mean absolute certainty that all occupational tasks are technically susceptible to automation (Frey & Osborne, 2017). The probability values assigned to each occupation factor in the above-mentioned engineering bottlenecks by using classifications (low, medium, and high) relating to nine sub-level variables (e.g., social perceptiveness, originality, and/or finger dexterity) to estimate the total level of social intelligence, creative intelligence, and perception and manipulation each occupation is comprised of. Thereafter an algorithm was developed to reproduce the categorisations generated by the technology experts to calculate and assign probabilities for remaining 632 occupations.

Using the calculated probabilities, different economic sectors were identified as containing more occupations at low, medium, or high risk of automation over the next decade or two. These results are presented in Table 1.

Table 1 Economic sectors with proportionally more occupations at low or higher technical risk of job automation (Frey & Osborne, 2017, p. 267)

High and medium risk sectors (Contain occupations with automation probability values mostly > 0.30)	Low risk sectors (Contain occupations with automation probability values mostly <= 0.3)
Transportation and material moving Production Installation, maintenance, and repair Construction and extraction Farming, fishing, and forestry Office and administrative support Sales and related Service	Healthcare practitioners and technical Education, legal, and community service Arts and media Computer, engineering, and science Management, business, and financial

Similar to past job automation trends, the model predicts more manual labour-intensive occupations in industry and manufacturing could be increasingly susceptible to automation. However, in contrast to past trends, low-skill and low-wage occupations across several sectors are predicated to be at higher technical risk of automation relative to medium- and high-skilled occupations or high-wage jobs – most of which require a bachelor’s degree or higher (Bughin et al., 2018; Frey & Osborne, 2017; World Economic Forum, 2020). Lower risk occupations are predicted to contain more non-routine tasks requiring originality, capabilities in the fine arts, negotiation, persuasion, social perceptiveness, and/or assisting and caring for others. This is due to persisting engineering bottlenecks associated with performing these tasks (Frey & Osborne, 2017). As a result, there could be an

increasing demand and returns for higher skilled labour and higher-order cognitive skills (Mandelman & Zlate, 2022; Ubalde & Alarcón, 2020). In the following section, the limitations and benefits of estimating future job automation are discussed.

2.3.1 The limitations and benefits of modelling job automation

Whilst the model developed by Frey and Osborne (2017) has been widely utilised in studies estimating the future extent of job automation across varying country contexts (Fuei, 2017; le Roux, 2018), several researchers have raised questions about the methodology employed and the results reported. First, noting that the algorithm used to calculate the job automation probability values was designed to replicate the smaller sample of risk categorisations proposed by the technology experts, some have questioned whether the subjectively determined categorisations are sufficiently accurate (Morgan, 2019). It has been argued that technology experts have at times overestimated the potential of new technologies in the past, such as overstating the comparative advantage of machines in performing tasks requiring flexibility and judgement capabilities (Arntz et al., 2016; Autor, 2015). While caution should be taken when using predictions based on the subjective assessments of experts, it would also be unreasonable to conclude, based solely on historic mispredictions, that experts have in this recent instance significantly overestimated the job automation scope of new technologies.

Another criticism of the model has focused on the assignment of probability values to entire occupations rather than to the constituent tasks within each occupation (Arntz et al., 2017; Autor, 2015). Because occupations consist of multiple tasks automation may affect some tasks but not others. Thus, automation of a submaximal number of constituent job tasks across multiple occupations may not necessarily result in the mass elimination of human occupied jobs (Arntz et al., 2016; Morgan, 2019).

Although the final list of probabilities reported by Frey and Osborne (2017) apply at the occupational level only, the initial risk categorisations generated by the technology experts did nonetheless consider the different types of constituent tasks within each occupation.

Aside from possible methodological issues, there are range of social and economic factors which add to the complexity of predicting future job automation. For instance, research indicates that companies' and organisations' future adoption of new technologies, such as humanoid service robots, could be constrained by consumers' possible experiences of discomfort when interacting with these type of human-facing technologies (Mende et al., 2019). Other socio-economic factors could also influence the speed of technological adoption. These may include: the costs associated with implementing new technological solutions in workplaces; shifting national and international supply and demand for human labour; the future extent of job offshoring; the amount of profit obtained through labour cost savings; the returns generated from increased productivity; and regulatory barriers in implementing new digital technologies (Arntz et al., 2016; Manyika et al., 2017).

When taking these different socio-economic factors into consideration, it is reasonable to conclude that predicting the exact scale of future job automation remains highly uncertain (Arntz et al., 2016). Yet, despite the uncertainty in predicting the precise quantity of future job automation, by proceeding with a more modest assumption that recent models can help to estimate the types of occupations which are likely to be more technically susceptible to automation, researchers have gained useful insights into the different groups of people/workers who could encounter automation-related risks over the coming decades (Fuei, 2017; le Roux, 2018). Identifying trends in skill and task changes within occupations using models

and insights on automation can also provide useful information to help current and future workers prepare for new occupational requirements. To illustrate some of these trends, the following section provides a brief overview of some predicted skill and task changes within occupations.

2.3.2 Automation-related skill and task changes within occupations

Broadly consistent with recent job automation models, a systematic review of literature identified several key skills associated with future developments in the world of work. These include skills such as leadership, self-management, creativity, problem-solving, teamwork, communication, adaptability, and knowledge of contemporary fields (e.g., new technologies) (Kipper et al., 2021). Similarly, results from global surveys of senior executives, including heads of human resources, strategy, and innovation departments of large companies from a broad range of job sectors, indicate the growing importance of domain-general skill types relative to physical capabilities. Taking a broad average across multiple sectors, the skills reported to be growing in importance were: critical thinking and analysis; problem-solving; self-management; working with people; management and communication of activities; and technology use and development (World Economic Forum, 2020).

In specific sectors such as the advance manufacturing sector, occupational task changes were reported to include a decrease in the proportion of information and data processing tasks and manual labour tasks performed by humans. Whereas an increasing proportion was reported for human-performed tasks involving reasoning and decision making and communication and interacting (World Economic Forum, 2020). Emerging skills in the advance manufacturing sector were reported to include technology use and critical thinking/innovation (Bughin et al., 2018; World Economic Forum, 2020). In the digital communications and information technology sector,

information and data processing tasks were reported to be increasingly subject to automation. While tasks requiring coordination, communication and interacting were suggested to be a growing proportion of human-performed tasks (World Economic Forum, 2020). The growing importance of social skills in digital jobs has been reported in other research as well (Colombo et al., 2019). Such skill and task changes within occupations, in combination with the increasing automation of certain job types, can create new and complex career risks for present and future workers. These risks, discussed in the next section, could stem from greater difficulties in making informed career choices as job options speedily change, along with developing personal attributes in congruence with rapidly shifting occupational requirements.

2.3.3 Studying young people's automation-related career risks

As previously highlighted, job automation is not a new phenomenon – dating back to at least the 1980s. While past automation was limited to a narrow range of sectors and occupations, the present-day possibilities are significantly greater. Accelerating technological advances and the novel possibility for both routine and some non-routine tasks and occupations to be automated has potentially important consequences for different groups which merit further study. This includes children and adolescents as future workers and career choice makers. Children and adolescents are important groups to consider when investigating the implications of automation and job change for career theory and practice (Hoff et al., 2022; Lent, 2018). Because automation-related changes may take a few decades to appreciably manifest (PwC, 2018), present and forthcoming generations of children could encounter the unique challenge of significant job changes coinciding with their important educational and career decision making points. The rapidly changing

availability of different occupations could make it increasingly difficult for a young person to make informed career choices and align their personal attributes with evolving occupational skill and task requirements. These difficulties are likely to lead to new and complex career risks.

The range and severity of these career risks or opportunity costs are difficult to specify comprehensively. Nonetheless, they could include unemployment or job loss in some cases, reduced career satisfaction, misspent time, skill gaps, and suboptimal monetary expenditure spent preparing for or attaining an occupation(s) affected by automation (Hoff et al., 2022; Lent, 2018; Lent & Brown, 2020). Due to average differences in the career goals, pursuits, and attainments of different groups of young people, these automation-related career risks are likely to be distributed unevenly. Investigating these risks, and the differences across groups, can therefore help career practitioners and other stakeholders to develop relevant forms of support to aid young people in developing their career aspirations and preparedness.

Estimating these career risks across different groups of children and adolescents requires two important elements: 1) a measure(s) to predict young people's future career-related choices and attainments; 2) a critical understanding of the factors that shape young people's career aspirations, choices, and attainments. These elements are explored in the following section, and they provided a basis for studying the career risks different groups of school students may encounter due to future job automation.

2.4 Career aspirations as predictors of occupational attainments

Career aspirations are generally viewed as a distinct construct from career interests or career expectations (Lent et al., 2002; Rojewski, 2005). For the purpose of this

research, a career or occupational aspiration was defined as an “individual’s expressed career-related goal(s)” that refers to attaining a specific occupation(s) or a job in a particular occupational field(s) (Rojewski, 2005, p. 132). Career aspirations are considered distinct from career interests in that the former represents an individual’s career goal(s) given ideal conditions, whereas the latter refers to an individual’s emotional disposition toward certain career options (Nikel, 2021; Rojewski, 2005). In contrast, career expectations refer to a person’s anticipated attainment of an occupation (Mello, 2008). Social Cognitive Career Theory indicates that career goals or aspirations are a precursor to and predictor of future career choices (Lent & Brown, 2019; Lent et al., 2002). Due to their theorised association with future career choices, the career aspirations of young people have been studied for several decades as predictors of later their career aspirations and occupational attainment in adulthood (Beal & Crockett, 2010; Schoon, 2001).

Research conducted by Schoon (2001) found that the career aspirations expressed by British students at age 16 were significantly related to their occupational attainment at age 33. This included over 50% of participants aspiring to and then obtaining jobs in the natural sciences and healthcare. When studying adolescents’ occupational aspirations and occupational expectations concurrently, evidence indicates the former are comparably or more significantly associated with adolescents’ future career-related activities and attainments (Beal & Crockett, 2010; Schoon & Parsons, 2002; Tang et al., 2008; Whitney, 1969). Career aspirations may therefore help to predict adolescents’ career pursuits (i.e., their future career-related activities and choices).

However, in the case of pre-adolescent children the predictive value of their career aspirations is less clear. Though some have claimed that the career aspirations held

by students of primary school age are likely to change over time and thus do not provide a reliable indication of their eventual occupational choice (Gore et al., 2017), others have suggested that primary school children's career aspirations are more stable than previously assumed (Chambers et al., 2018; Hughes & Kashefpakdel, 2019). The empirical evidence pertaining to these claims and the implications for predicting children's career pursuits are discussed next.

2.4.1 The stability and predictive value of children's career aspirations

Across a period of eight months, research conducted in the USA with 8 year-old students found 70% of girls (74 out of 105) and 69% of boys (68 out of 98) expressed identical career aspirations at the beginning and end time points (Trice, 1991). Additional longitudinal research involving children from the United States found that from primary/elementary school to the end of secondary/high school there were small proportional changes in participants' aspirations across several job categories. Using panel data to track changes in the occupational aspirations of 65 American students from second to twelfth grade, similar proportions were found holding career aspirations at the beginning and end time points in social (34% versus 38% respectively), investigative (25% versus 20%), and enterprising (20% versus 15%) job categories. Larger differences were evident in the artistic (12% versus 5%) and conventional (2% versus 12%) occupational categories (Helwig, 2003). These results suggest that at the aggregate level, rather than the individual level, career aspirations may follow a fairly predictable trend from primary school. This idea is supported in other survey research.

Similar typological results concerning career aspirations have been found in a study combining separate surveys involving British primary school students (Chambers et al., 2018) and secondary school students (Mann et al., 2013). This comparative

analysis of two large-scale survey results indicated that while there were significantly fewer 17-18 year old students aspiring to careers in the art, culture, entertainment, and sports sector compared with students aged 7-8 (16% versus 44% respectively), in the vast majority of other sectors (13 out of 16 sectors), similar or identical proportions were measured across the two age groups (Rogers et al., 2020).

The results from this collection studies can be understood in the following way: though changes in children's career aspirations at the individual level are difficult to reliably predict between the ages 7-18, these longitudinal and cross-sectional study results provide evidence in support of the claim that in the aggregate or at the group level, changes in children's career aspirations are proportionally small and largely predictable. When combined with the evidence showing adolescences' career aspirations as strong predictors of their future occupational attainments (Schoon, 2001; Trice & McClellan, 1993), there is reason to conclude that primary and secondary school students' career aspirations can provide useful insights into the future career choices young people are likely to make. From these insights into young people's future career choices, it is possible to estimate the automation-related career risks different groups may encounter (including the developmental period at which children may adopt higher-risk career aspirations). For interventions and stakeholders who support children's career aspirations and development, this information could be beneficial to make more informed decisions about how best to support different children in preparing for their future careers.

To identify and explain differences among children's career aspirations and the risks associated with job automation, it is important to examine the personal and environmental factors that shape children's career aspirations (Bandura et al., 2001; Lent & Brown, 2019). An understanding of these factors can help to discern why

certain groups (e.g., gender, social class, etc.) tend towards specific occupations, some of which may be more susceptible to automation. In this regard Social Cognitive Career Theory has offered researchers a useful framework for identifying these personal and environmental factors, along with their interrelations (Makransky et al., 2020). As the guiding theoretical framework for this research, Social Cognitive Career Theory is discussed next.

2.5 Social Cognitive Career Theory

Social Cognitive Career Theory (henceforth SCCT) has its antecedents in Social Cognitive Theory, which in turn developed from Social Learning Theory. Social Learning Theory first emerged to explain how new behaviours could be learnt through observation and imitation of others, and/or through the observation of rewards and punishments – known as vicarious reinforcement (Bandura, 1977). An expansion of Social Learning Theory took place to better account for the complex way in which individuals acquire behaviours, thoughts, and feelings which are not straightforwardly attributable to stimuli from the environment or via direct observation of models. This shifted emphasis toward the role of cognition in learning.

Social Cognitive Theory (henceforth SCT) contends that individuals possess the agency and capabilities to self-regulate, self-reflect, and to engage in symbolic thought (Bandura, 1991, 2001). With the learner regarded as an active recipient of information, their cognition, environment, and behaviour are hypothesised to all mutually affect one another (Bandura, 1977). Information that is acquired from the environment is influenced by the type of model (i.e., from demonstration, verbal instruction, and symbolic formats such as media), along with a series of cognitive and behavioural processes relating to the learner's attention, retention, reproduction, and motivation (Bandura, 1977, 2001). Learning is more likely to occur in

circumstances in which the individual has a close identification with the model and high levels of self-efficacy (Bandura et al., 1997). A person's outcome expectancies or perceptions of the outcome(s) associated with performing a particular behaviour are also thought to influence their cognition and imitation of behaviours (Bandura, 1989; Bandura et al., 1997).

Several career development theorists have attempted to extend and apply SCT into the domain of careers (Lent, 2013b; Lent et al., 1994). In developing SCCT, social cognitive learning constructs were unified with trait-and-factor concepts and career developmental ideas (Tang, 2019). SCCT was devised to explain the interplay between psychological and environmental variables and processes by which individuals form career interests and goals, make career choices and actions, and achieve career attainments (Lent et al., 1994; Sheu & Bordon, 2017). A depiction of SCCT is shown in Figure 2 below.

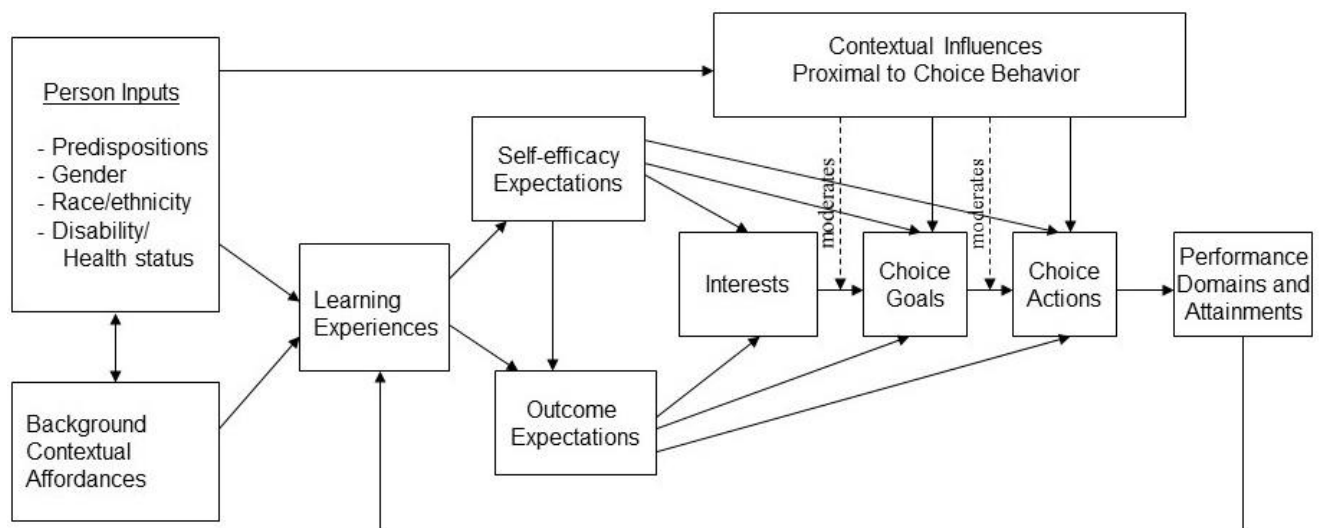


Figure 2 SCCT model of career-related interest development and choice-making (Lent & Brown, 2019; Lent et al., 1994)

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It is theorised that a person's accumulated learning experiences, as mediated by their personal inputs (i.e., predispositions, gender, ethnicity, etc.) and background contextual affordances (e.g., those from home and school environments), directly influence the formulation of their self-efficacy beliefs and outcome expectations (Lent & Brown, 2019; Lent et al., 1994). These beliefs and expectations in turn are understood to influence a person's career-related interests and goals, which subsequently determine their subsequent career-related actions and attainments (Lent & Brown, 2019; Lent et al., 1994).

Self-efficacy beliefs are defined as a person's belief in their capacities to execute a set of actions necessary to achieve specific outcomes (Bandura et al., 2001).

Whereas outcome expectations refer to the beliefs an individual holds about the effect of a given action(s) on achieving a particular outcome (Bandura et al., 2001).

High self-efficacy beliefs relating to the tasks of which an occupation is comprised, in conjunction with expected outcomes associated with attaining a specific occupation, will play an important role in determining whether or not a person develops an interest in and goals for a given occupation or industry (Sheu & Bordon, 2017).

A person's career choice goals and actions will also be influenced directly and indirectly by contextual influences proximal to decision-making points. In terms of an indirect influence, barriers or inadequate supports (e.g., from the wider culture, job markets) may make it less likely for the person to translate their career interests into

¹ Reprinted from Journal of Vocational Behavior, Vol 45, R.W. Lent, S.D. Brown, & G. Hackett, Toward a Unifying Social Cognitive Theory of Career Interest and Academic Interest, Choice, and Performance, Pages 79-122, Copyright 1994, with permission from Elsevier.

goals and actions in cases where they perceive the contextual influences to present insurmountable obstacles toward attaining their career-related goals (Lent & Brown, 2019; Lent et al., 2000). In terms of a direct influence on choice making or goal implementation, personal career goals may be modified in response to perceived or actual social and economic influences (e.g., pressures from the culture or parents overriding personal career preferences). Contextual influences may therefore include influences on people's occupational goals and choices based on what emerges or is displaced as a result of job automation (Hirschi, 2018).

There are several important reasons to use and critically examine SCCT within the context of increasing automation and job change. The first is that because the theory outlines various personal factors (e.g., gender, age, ethnicity) and environmental factors (e.g., parents and socio-economic background) which are likely to shape children's career aspirations and choices, it provides a lens to explore and possibly influence the variables that may play a role in determining the automation-related career risks children encounter over the coming decades. Another reason to draw on SCCT is to critically examine the theory's underlying assumptions about potentially stable person-occupation alignments or matches. While SCCT recognises that contextual influences such as job markets can impact young people's career aspirations and choices/attainments, a sustained match between a person and an occupation is still assumed to be achievable except in cases where the person encounters insurmountable environmental barriers (perceived or actual) (Lent, 2013a; Lent & Brown, 2020). However, when examined from the perspective of accelerating automation and rapidly changing occupational requirements, this person-occupation matching assumption may be subject to new limitations which

merit investigation. Further discussion of these limitations is provided later in this chapter.

In summary, the value of SCCT for this research is that it provides a cohesive framework to help predict, explain, and support children's and adolescents' career aspirations and preparedness. Because SCCT incorporates a dual approach of person-occupation matching while recognising the influence of contextual factors, it was beneficial for the purposes of this research. Namely, to help predict and explain automation-related career risks across different groups of children, as well as for critically examining existing support for children's career aspirations and preparedness within the context of rapidly changing job markets. As SCCT specifies a range of personal and environmental factors relevant to children's career aspirations, it was valuable to explore the empirical evidence pertaining to these factors to gain further insights into how they shape children's aspirational development. This empirical evidence is examined in the next section.

2.6 Factors influencing children's career aspirations

2.6.1 The influence of age

A person's age can be a relevant factor contributing to the formation of their career aspirations (Gottfredson, 2002; Lent et al., 2002). Prior to adolescence, children tend to hold less stable career aspirations and express more aspirations for occupations in art, entertainment, and sports fields rather than jobs categorised as conventional (Helwig, 2003; Rogers et al., 2020). As children enter adolescence a larger proportion tend to shift from more fanciful or unrealistic aspirations to those classified as more realistic (Helwig, 2001; Hirschi, 2010; Trice & McClellan, 1993). Helwig (2001) suggests a shift toward more realistic and conventional career aspirations

arises in part due to children's growing self-awareness and knowledge of the world of work.

From a SCCT perspective, a child's age or biological inputs contributes to their accumulated learning experiences, which can in turn modify their self-efficacy beliefs and outcome expectations for different careers. These beliefs subsequently determine children's career interests and goals (Lent & Brown, 2019; Lent et al., 2002). However, the mechanisms proposed in SCCT may not on their own provide a sufficient explanation as to why a distinctive shift in children's career aspirations toward more realistic and conventional careers occurs during adolescence. To explain this shift using SCCT concepts there would need to be a specific mechanism(s) producing a distinctive change in children's self-efficacy beliefs and outcome expectations at a particular developmental time point. Yet, in this regard SCCT does not provide a detailed explanation of a specific developmental process occurring in adolescence which could explain this belief or aspirational shift.

An explanation detailed in the Theory of Career Circumscription, Compromise, and Self-Creation provides a valuable supplementary account. This developmental theory proposes that after several stages of circumscribing different career options using externally acquired criteria, such as criteria related to gender and social class, at around age 14 children shift in their orientation more towards a career appraisal based on their internal, unique conception of self (Gottfredson, 1981; Gottfredson, 2002). At this developmental stage children may be more inclined to draw on their self-understanding to select from the careers that personally interest them and that have not already been eliminated from consideration based on the perceived attainability of the career or other perceived barriers, including those relating to social prestige and gender (Gottfredson, 2002). Research involving Italian school

students found that the adolescent participants were more likely than the younger participants to use career reasoning strategies which considered personal interests, abilities, and job requirements when forming their career choice (Howard & Walsh, 2010).

These developmental processes may be important in understanding when and why children may aspire to more occupations at risk of automation. Children's broadening knowledge of occupations with age, along with an orientation towards a unique self-conception in adolescence, may make it possible for noticeable shifts toward more realistic and conventional (and possibly higher-risk) career aspirations to occur during adolescence (Helwig, 2001). However, this is not to suggest that pre-adolescent children do not possess relevant career knowledge or that there are not possible implications of automation and job change for younger children. Evidence shows children at both the lower and upper primary school levels can possess some awareness of their own dispositions, capacities and interests, along with the ability to associate these characteristics with specific careers (Hartung et al., 2005; McMahon & Watson, 2005; Nazli, 2007; Walls, 2000).

There nonetheless remain frequently observed gaps in children's career knowledge which raise implications for those supporting their aspirations and preparedness for the changing world of work. A study involving school children found that they can often be inaccurate in judging the availability of occupations (Walls, 2000), as well as factors of career satisfaction, income, and the status of different occupations (McMahon & Watson, 2005; Nazli, 2014). These areas of limited career understanding may be increasingly consequential for children's career goal setting as new technological developments contribute to accelerating changes in the availability and characteristics of different occupations. In addition to age, other

personal variables such as gender can significantly influence children's career aspirational development (Gottfredson, 2002; Lent & Brown, 2019).

2.6.2 The influence of gender

From an early age children begin to orient themselves to sex roles. It is thought that they gradually assimilate the concept that certain behaviours and occupations are associated with each sex (Care et al., 2007; Gottfredson, 2002). Studies involving children aged 4-6 years old have found that more boys than girls expressed aspirations for occupations more commonly held by men and vice versa (Care et al., 2007; Lee, 2012). Cross-national surveys involving children between the ages of 7-11 indicates average gender-based differences in career aspirations span low-, middle-, and high-income country contexts (Chambers et al., 2018; Nikel, 2021). These results show proportionally more girls aspire to occupations involving substantial interaction with people (e.g., nurse, hairdresser). Conversely, boys' career aspirations more often entail working predominantly with things or objects rather than people (i.e., builder, engineer). Large-scale research involving approximately 22,000 American students in grades 8 and 10 revealed that average gender-based differences in adolescent students' occupational aspirations were categorised along the people/things divide as well (Howard et al., 2011).

Average gender-based differences in STEM career aspirations have also been reported. Studies show a larger proportion of male students express career aspirations aligning with technology, engineering, and physical science fields (Holmes et al., 2017). Whereas a higher proportion of female students express aspirations for more people-centred STEM occupations such as doctor and vet (Chambers et al., 2018). Average status differences in children's career aspirations have also studied to identify a possible gender-related component. Research studies

involving secondary school students in the USA and primary school students in the UK both reported a larger proportion of female students expressing aspirations for higher prestige occupations than male students (Chambers et al., 2018; Howard et al., 2011). Presently in these higher-income countries female students are also on average achieving higher educational attainment at most levels of education than their male counterparts (OECD, 2015; Reilly et al., 2019). Several studies have found that school students' level of educational attainment can contribute significantly to the level or status of their career aspiration (Baker et al., 2014; Gore et al., 2017; Holmes et al., 2017).

While there may currently be a larger proportion of female students holding higher status career aspirations, there are nonetheless possible counteracting psychosocial factors which merit consideration. For example, average gender-based differences in outcome expectations may provide a counteracting influence in that female students are potentially less likely to form career goals deriving from status or money considerations (Kang et al., 2019). Similarly, when controlling for educational attainment, female students may on average report a lower self-concept (Parker et al., 2018). A lower self-concept is associated with low status career aspirations (Gottfredson, 2002).

The empirical findings explored in this section highlight several gender-based differences in career aspirations. These include proportionally more male students aspiring to manual labour-intensive jobs and lower status occupations as well. Average aspirational differences by gender may be increasingly consequential due to the potential for differential automation of various types of occupations, such as manual-labour intensive roles and lower-skilled occupations. In conjunction with personal variables, factors associated with children's background environment can

contribute to their career learning experiences and aspirations (Lent & Brown, 2019). One of the prominent background influences concerns the role of parents.

2.6.3 The influence of parents

Parental influences, such as through encouragement and behaviour modelling, are recognised to contribute to the formation of children's career aspirations within the framework of SCCT (Lent et al., 2002). Qualitative research carried out in China indicated that parental influences on primary school children's career aspirations often involved responding positively to their child's interests, conveying career values, and emphasising education (Liu et al., 2015). Parents may also contribute to their children's career aspirational development through expressing high expectations and high-status aspirations. A study exploring students' career aspirations at age 12 found that those expressing high status career aspirations and expectations frequently had parents who held high status aspirations and expectations for their child's career (Creed et al., 2007).

Alignments between children's career aspirations and their parent's actual occupation tend to be more pronounced in younger age groups (McDevitt et al., 2013; Trice & Knapp, 1992). Studies with primary school students have reported a moderate association between children's occupational aspirations and their parents' actual occupations (Lee, 2012; McDevitt et al., 2013; Trice & Knapp, 1992). Because parents can contribute to the types of career aspirations expressed by their children, parents could play a role in shaping the automation-related career risks children encounter. Additionally, variables spanning social class, ethnicity, leisure activities, social media, TV, and entertainment media could be relevant contributing factors as well (Archer, Dewitt, & Wong, 2014; Chambers et al., 2018). The next section

explores the influence of socio-economic background on children's career aspirations.

2.6.4 The influence of socio-economic background

Children's socio-economic background has been widely studied as a potentially important determinant of their career aspirations. Research carried out by Moulton et al. (2018) with British children aged 7 found those brought up in families with a higher socio-economic status were on average more likely to hold higher occupational aspirations than their peers raised in lower socio-economic families. Gutman and Akerman (2008) similarly found that British female ethnic minorities from high socio-economic backgrounds held higher career aspirations than their female counterparts from lower socio-economic backgrounds. The influence of socio-economic background on children's career aspirations and expectations have also been reported for those of secondary school age (Cheng & Yuen, 2012; Mann et al., 2020).

However, despite the frequently reported influence of socio-economic background on children's career aspirations, when compared with other variables, multiple studies have found the influence on primary and secondary school students' career aspirations to amount to small effect size (Baker et al., 2014; Gore et al., 2015; Howard et al., 2011; Robinson & Diale, 2017). For instance, Gore et al. (2017) carried out a multivariate analysis of the career aspirations of 6492 students (school years 3-12) from 64 public schools in Australia and found variables such as socio-economic status, indigenous status, and school location were weaker predictors of students' career aspirations than were school year, gender, and prior achievement.

Qualitative studies exploring the reasons for this comparatively small influence have provided valuable insights. Several studies examining the aspirations of teenagers living in lower-income areas of the UK reported that the participants' aspirations were not significantly impacted by actual or perceived labour market constraints (Kintrea et al., 2015; St. Clair et al., 2013). Instead, the authors specified the importance of understanding local complexities arising from the intersecting factors of class, ethnicity, and institutional influences, as well as supporting low-income children with the knowledge of how to make their aspirations attainable. Gomez and Beachum (2019) further contend that enhanced knowledge of and exposure to different employment options could be beneficial to foster the development and implementation of lower-income children's career aspirations.

In summary, the evidence presented here suggests children's socio-economic background can impact their career aspirations, but local particularities and other intersecting factors are likely important to understand and support the career aspirations of different socio-economic groups. Ascertaining why certain socio-economic groups may pursue lower status or wage occupations is important as such occupations could be increasingly susceptible to automation (OECD, 2018). Next, the following section moves on to examine two central psychological constructs within the framework of SCCT and how they shape children's career interests and aspirations.

2.6.5 The influence of self-efficacy beliefs and outcome expectations

Research by Gore et al. (2018) with primary and secondary school students found that participants' self-beliefs of their ability to perform in a given domain, along with perceiving where they stand relative to their peers, significantly influenced whether or not they formed and maintained career aspirations in fields such as medicine.

School students' interest in mathematics and science self-efficacy beliefs have been reported to predict their career aspirations in STEM fields (Mau & Li, 2018). Some researchers have suggested that possessing stronger non-STEM career interests and/or having low STEM self-efficacy beliefs may significantly sway students away from expressing STEM career goals, even when students report some interest in STEM fields (Archer et al., 2012).

Possibly functioning in a bidirectional relationship with self-efficacy beliefs, a person's prior attainment may lead them to hold positive self-beliefs about their ability to achieve in a specific field and vice versa. Several studies have found that children's prior level of educational attainment can contribute significantly to their holding of particular career aspirations as well as the level of their aspiration (Baker et al., 2014; Gore et al., 2017; Holmes et al., 2017). A study conducted by Gore et al. (2017) revealed school students' prior achievement can be one of the most powerful predictors of their career aspirations, with higher-status career aspirations being positively correlated with higher prior attainment.

Young people's outcome expectations can also contribute to the career interests and aspirations they form. Recent research conducted in Finland sought to uncover the varying effects of different outcome expectations/future career perspectives on 13-year old boys' and girls' interest levels in science (Kang et al., 2019). These future career perspectives included an outcome orientation (e.g., making money or achieving status), personal time orientation (e.g., having sufficient personal time or family time), and innovation orientation (e.g., inventing new things or producing new knowledge). Results revealed female students' science interest was positively correlated with personal time- and innovation-oriented future career perspectives, and negatively correlated with outcome-oriented future career perspectives. In

comparison, male students held higher outcome-oriented future career perspectives, placing higher value on the money/status associated with a science career (Kang et al., 2019). Because the outcomes associated with different careers maybe distinctly changing due to accelerating automation, developing realistic and positive outcome expectations and self-efficacy beliefs could be increasingly important for children's career goals and preparedness (Lent, 2018). The next section explores some of the emerging environmental supports and barriers that may impact children's career pursuits.

2.6.6 The influence of environmental supports and barriers

As young people approach career and educational decision-making points, SCCT suggests they can encounter environmental barriers and supports that may influence the (re)formation of their career aspirations and strengthen or weaken the implementation of their preferred career choice(s) (Lent & Brown, 2020; Lent et al., 2000). Environmental supports and barriers can be both perceived and actual (Lent et al., 2000). An actual barrier may include the inability to pay for a preferred educational course, while a perceived barrier may involve a person's perception about the availability of job opportunities in their locality. New barriers and opportunities resulting from automation and job change may have important implications for young people's career goal setting and preparedness.

Several studies examining the factors young people consider when making a career choice indicate that emerging trends in the economy, technology, cultural exchange, and other factors associated with globalisation are reported as important to their career deliberations (Mbilini et al., 2019; McDevitt et al., 2013). McDevitt et al. (2013) found that 141 children across various primary and secondary school year groups reported their knowledge of technology, proficiency in two or more languages,

exposure to different cultures, and ability to travel as important factors in making decisions about their career. However, while technology and changing socio-economic conditions have been reported as factors potentially informing young people's career decision making, results from recent surveys point to possible knowledge and attitudinal barriers related to automation and job change (Speakers for Schools, 2018; WorldSkills & OECD, 2019). These perceived barriers are discussed next.

2.6.6.1 Perceived job automation barriers

A survey involving just under 1,000 British school students aged 11-18 years old reported that 71% of the respondents expressed the concern that it would be more difficult to obtain a job in 2030 compared to the present day due to automation and changing job types (Speakers for Schools, 2018). A larger survey involving 15,000 young people aged 18-24 at the end of general education and VET programmes from 19 higher-income countries (500-1000 respondents per country) found similar results. Across the participating countries an average of 50% of respondents expressed being confident they will find the find job they really want, while only 39% of UK respondents reported being confident in securing their preferred career (WorldSkills & OECD, 2019). Only 49% of British respondents expressed optimism that technological change would provide them with job opportunities in the future, compared with an average of 56% across all participating countries (WorldSkills & OECD, 2019).

Along with many young people expressing pessimistic attitudes, limited knowledge of job automation trends and the changing requirements of work could present further impediments to their career goals and choice making. Research involving British school students reported that only 35% of the 11-18 year olds surveyed believed that

there will be more jobs requiring creativity in the future (Speakers for Schools, 2018). While around 55% of respondents anticipate there will be more jobs requiring technical skills (e.g., dealing with complex data). A large proportion of these expressed viewpoints may be inconsistent with trends observed in the labour market and with future technological impacts on jobs and skill requirements (Frey & Osborne, 2017; World Economic Forum, 2020). Indeed, without a strong understanding of future job opportunities and skill requirements, it is possible many young people may not be sufficiently well equipped to make informed career decisions and effectively prepare for their future careers.

The empirical evidence explored in this section, as well as the literature on future job automation discussed previously, reveal possible environmental barriers, both perceived and actual, which present implications for children's and adolescents' career aspirations and preparedness for the changing world of work (Hirschi, 2018; Lent, 2018). Problems linked to pessimistic job attainment attitudes, limited self-beliefs and social supports, and knowledge gaps associated with the changing world of work, suggest many children and young people could encounter automation-related career risks (e.g., unemployment) or opportunity costs as they reach career decision making points. Yet, based on the group-related evidence previously discussed, there is reason to believe that these automation-related career risks may not be distributed evenly. An overview of these emerging problems is presented next.

2.6.7 Emerging problems for children's career aspirations and preparedness

So far it has been shown that future job automation, while difficult to quantify precisely, is likely to affect a wide range of routine and some non-routine occupations as well as the task and skill requirements within many roles. Young

people as future workers and career choice makers are likely to be affected by these changes and may encounter various career risks or opportunity costs as a result of pursuing their preferred careers (e.g., financial loss, unemployment, skill gaps, etc.). Children's and adolescents' career aspirations can provide insights into their future career choices and can thereby help to estimate the automation-related career risks they may encounter. Moreover, there is reason to suppose that these risks may impact some groups more than others. SCCT and recent empirical evidence indicates that personal factors such as age and gender, in combination with environmental factors including parental influence and socio-economic background, can shape children's career aspirations in differing and important ways. Potentially limited knowledge and pessimistic attitudes concerning automation and job change may also mean that many young people are not well prepared to make informed career decisions in the context of a rapidly changing world of work.

To-date little empirical research has been dedicated to understanding the career risks different groups of children (e.g., social class, gender, parental occupation) could encounter due to automation and job change (Hoff et al., 2022; Lent, 2018). Investigating these automation-related career risks and the differences across multiple groups can help to reveal important disparities which may contribute to existing social inequities. This research can also be of value for developing more strategically informed approaches to support children in preparing for a rapidly changing world of work, including preparedness for skill and task changes within occupations (both lower- and higher-risk roles).

From gaining an understanding of the automation-related career risks that are likely to affect young people and different groups, there arises a subsequent question concerning what approaches could help to address the identified problems. Several

scholars have noted that interventions to support people's career goals and choice making are becoming more complex due to increasing career transitions and job automation (Hirschi, 2018; Lent & Brown, 2020). The following section sets a foundation for investigating these complexities by first outlining a rationale for supporting children's career aspirations and preparedness. Thereafter, the potentially emerging complexities of supporting children's career aspirations and preparedness for automation and job change are discussed from a theoretical and practical perspective.

2.7 Supporting children's career aspirations and preparedness

2.7.1 A rationale for supporting children's career aspirations and development

A theoretical basis for supporting children's career aspirations and development dates back several decades (Gottfredson, 2002; Lent & Brown, 2019; Super et al., 1996). Despite this career provisions and interventions with pre-adolescent children have a noticeable shorter history when compared with those involving adolescents and adults (Porfeli et al., 2008). Relative to adolescents, pre-adolescent children are thought to engage in more fantasy-based career thinking and express career aspirations which are less stable and realistic (Gore et al., 2017; Howard & Walsh, 2010). There may also be the frequently held assumption that conducting career interventions with children implies that by the end of the intervention (or soon after) they are expected to reach firm career plans. These beliefs have perhaps contributed to a certain amount of scepticism and comparatively smaller body of career interventions involving pre-adolescent children (Porfeli et al., 2008).

While pre-adolescent children are more likely to exhibit fantasy career thinking and aspirations, as previously discussed, their aspirations are more stable and realistic than frequently assumed, and they have demonstrated the capacity to engage in

career exploration and planning (Ginevra & Nota, 2018; Helwig, 2001; Rogers et al., 2020; Walls, 2000). Moreover, conducting career interventions with children does not necessarily imply they must form firm career plans, but may instead help children to broaden their career options and acquire career adaptability resources or other capacities (Ginevra & Nota, 2018). Indeed, prior to adolescence children are already engaging in a process of forming a vocational identity and narrowing down their career options based on various social criteria (e.g., gender and social class). This is often done without rationale deliberation of the soundness of the criteria (Gottfredson, 2002; Howard & Walsh, 2010). Consequently, there are possible opportunities to support children in broadening their career knowledge, attitudes, and reducing their early circumscription of career options (Porfeli et al., 2008).

Several reviews of career intervention studies have reported the growing number of studies focusing on children at the primary school level (Hughes & Kashefpakdel, 2019; Hughes et al., 2016; Kashefpakdel et al., 2018; Knight, 2015). Career intervention studies with children and adolescents have been carried out to influence positive changes in various career variables, including career aspirations, exploration, knowledge, attitudes, and adaptability (Ginevra & Nota, 2018; Peterson et al., 1999; Piesch et al., 2020; Turner & Lapan, 2005; Whiston et al., 2011). This growing body of evidence shows the possible benefits of conducting career interventions with children and adolescents, in addition to the role different stakeholders or organisations may play in supporting children's career aspirations and development (Kashefpakdel et al., 2018; Taveira et al., 2017; Watson & McMahon, 2005).

However, there are important gaps in this body of literature. A recent review of literature identified limited empirical evidence covering the implementation

complexities associated with conducting career intervention programmes with children (Watson & McMahon, 2022). Research into the practical challenges and opportunities of supporting children's and adolescents' career development is important as accelerating automation and job change present practitioners with complex decisions about how to conduct career provisions with young people (Hirschi, 2018; Lent, 2018; Porfeli et al., 2008). From a theoretical perspective, rapid changes in the world of work and career pathways are also challenging person-occupation matching processes which underlie career goal/choice interventions and various theories (Lent, 2013a; Lent & Brown, 2020). The following sections explore these potentially emerging theoretical and practical complexities in more detail.

2.7.2 Emerging theoretical and intervention approach complexities

Theories and approaches incorporating a process to compare or match persons to occupations remain a common part of the contemporary professional toolkit to facilitate informed career goal setting or choice-making (Lent, 2013a; Lent & Brown, 2020). This process typically includes opportunities for self-reflection (e.g., identifying personal values, skillsets, etc.), exploring relevant career options and learning about their requirements and offerings, and a subsequent comparison or matching process between a person's self-conception and a good-fitting career option(s) (Lent & Brown, 2020; Parsons, 1909). Interventions may also draw on this matching approach to support children and adolescents (or specific subgroups) to aspire to certain occupations/sectors, such as encouraging more girls to learn about and pursue STEM fields (Duran et al., 2014; González-Pérez et al., 2020).

2.7.2.1 Limitations with matching approaches

Embedded in the matching process is the assumption that there are relatively stable features of persons and work environments that can be rationally understood,

compared, and matched (Lent & Brown, 2020). Yet, due to the increasing possibility of multiple career transitions and occupational changes resulting from automation a straightforward person-occupation comparison or stable match has become more difficult to achieve (Lent, 2013a, 2018; Lent & Brown, 2020). As jobs are increasingly displaced and created by the introduction of new digital technologies (Manyika et al., 2017), it will become harder for young choice makers to explore an evolving range of job opportunities and learn the rapidly changing skill and task requirements within occupations. Career goal/choice interventions targeting specific sectors and/or groups of young people may also face emerging complexities as automation differentially impacts occupations and creates new career risks for different groups.

Due to the challenges of achieving a good-fitting person-occupation match, some have argued the core concept of career theory should instead centre around career adaptability as a set of resources to manage change and uncertainty (van Vianen et al., 2009). Career adaptability resources, such as career concern, curiosity, control, and confidence, have been proposed as useful capacities to help people navigate the changing world of work (Savickas, 2013). A shift toward these capacities, it is argued, could promote children's and adults' flexibility to respond to ongoing workplace change, cope with unexpected career events, build resilience, and develop a propensity to explore various possible selves and future work possibilities (Savickas, 2011, 2013). Rather than focusing on achieving alignments between persons and occupations or predicting career trajectories, career theories based on constructivism, such as Career Construction Theory, emphasise the dynamic interaction between self and environment (Tang, 2019). Importance is given to how people can build a career through continuous personal and social construction

processes, and ultimately author a subjective career that fits the person's meaning of work and life (Savickas, 2013; Tang, 2019).

In contrast, other scholars have suggested that whilst changes to job markets and career pathways are occurring, and there is a growing need to promote career adaptability, this does not invalidate the benefits of helping choice makers find (as near as possible) a compatibility between their personal traits and an occupation in which they may perform successfully (Lent, 2013a; Lent & Brown, 2020). Likewise, theories centred around career adaptability have their own set of challenges. One of these challenges relates to the difficulty people typically face in speedily developing new skills and proclivities to shift from one career pathway to another potentially disparate pathway (Lent, 2013a). Another challenge concerns a person's tendency to circumscribe various career options in childhood using personal and social criteria (Gottfredson, 2002; Helwig, 2001). Certain career options will become more appealing or perceived as more realistic relative to others. This leads to a narrowing of career options and a reduced possibility for a person to shift into differing career paths in which they possess limited self-efficacy beliefs and outcome expectations (Lent, 2013a).

2.7.2.2 Using and investigating matching theories and approaches

Whilst recognising the possible limitations with person-occupation matching approaches and theories, this research nonetheless benefitted from drawing on one of these theories (SCCT) while also critically examining potential new shortcomings in the theory. The benefit of theories specifying a person-occupation alignment process is that they can provide a basis for predicting career trajectories and thus help to identify those who may encounter future career risks. Such theories can also inform explanations and interventions to help people find or pursue specific career

options they are likely to be satisfied with and in which they can achieve success in the foreseeable future (Lent, 2013a). Drawing on these theoretical insights and approaches some researchers have highlighted the potential individual benefits (e.g., higher paying employment) and social benefits (e.g., reducing group disparities in occupational attainments) of supporting young people toward specific career pathways, such as STEM careers (Piesch et al., 2020).

As mentioned above, SCCT retains a person-occupation alignment focus while also recognising the influence of environmental barriers and supports, including changing job markets, which can affect people's development of well-fitting career plans, goals, and attainments (Lent, 2013a). This dual application affords the possibility to critically examine career aspiration interventions with children, while also providing valuable conceptual tools to help explain children's career pursuits (Makransky et al., 2020). For these reasons SCCT was used in this research to help explain the automation-related career risks associated with children's career aspirations, as well as to examine the complexities of supporting children's career aspirations and preparedness within the context of a rapidly changing world of work.

Nonetheless, despite the extensive empirical research into SCCT, it has been recognised that less research has been dedicated to studying the environmental factors shaping career aspirations and preparedness, including supports and barriers concerning changing job markets (Lent & Brown, 2019; Lent et al., 2000). Increasing job automation has in particular received limited attention as an actual and perceived career barrier (Lent, 2018). In this respect this thesis could contribute to the development of SCCT by investigating the automation-related barriers, both actual and perceived, that may impact the career pursuits and preparedness of young

people. This research could also inform ongoing debates on the viability of achieving person-occupation alignments or matching approaches with young people.

In summary, it has been shown that commonly used theories and approaches to support children and adolescents in forming career aspirations/choices may face emerging difficulties due to increasing automation and job change. Because technology may both create and displace a range of routine and some non-routine occupations and tasks, it is becoming more complex to support young people in exploring an evolving range of job opportunities and the rapidly changing skill and task requirements within occupations. Differential impacts from job automation may also create new career risks for different groups that may not be addressed by existing intervention approaches which target specific occupations and groups.

Given these possible issues and the limited empirical research investigating how job automation may raise complexities for career aspiration interventions (Lent, 2018), there is a need to critically examine how recent career aspiration intervention approaches with young people have/have not addressed job change and the risks associated with automation. This can help to reveal insights and gaps in how young people's career aspirations are supported within the context of rapidly changing career conditions. Beyond career aspiration interventions, there are potentially emerging challenges and opportunities for career education provisions and different stakeholders who contribute to children's career preparedness. The next section discusses some of these emerging practical complexities and challenges for stakeholders to support children's career preparedness for automation and job change.

2.7.3 Stakeholder and practical complexities

Provisions supporting children's career development and preparedness have often been organised by multiple stakeholders and organisations operating at various levels (Taveira et al., 2017). At the micro and meso levels (i.e., the most immediate environmental settings for the child), teachers, schools, and families may organise formal or informal career-related learning experiences for children (Taveira et al., 2017). At the macro level (i.e., more distal influences affecting the child), governmental policy and decision making can shape the school curriculum and support services children access to aid their career development (Taveira et al., 2017). Because children are legally required to attend schools on a regular basis throughout most of their childhood, schools are frequent sites for organised career learning and guidance activities for children and adolescents. Recent research has highlighted some of the opportunities and contextual/practical challenges of implementing these school-based career activities.

For example, survey research involving 51 schools in England found that most teacher respondents (84%) organised curriculum-linked career activities. These activities were thought to be beneficial for enabling students to learn about work and life, with most respondents (81%) also suggesting they can help foster students' confidence and self-efficacy (Hughes & Kashefpakdel, 2019; Kashefpakdel et al., 2019). Respondents also reported use of parental engagement events and programmes with career volunteers to impart career-related ideas and attitudes (Hughes & Kashefpakdel, 2019; Kashefpakdel et al., 2019). A separate survey of 250 primary schools across multiple regions of the UK reported a similar range of career-related activities and events (e.g., aspiration days and enterprise days). Most

of the survey respondents indicated they have only organised career-related activities on either a yearly (43%) or termly (41%) basis (Kashefpakdel, 2018).

Survey respondents also suggested several practical challenges in implementing career education provisions in schools. These challenges have included: the lack of time due to competing curricular demands; limited capacity among teachers and non-teaching staff to plan and deliver quality career-related learning activities; and establishing and maintaining partnerships with local employers (Hughes & Kashefpakdel, 2019; Kashefpakdel et al., 2018). Many teacher respondents (57%) recommended further training on how to integrate career-related learning into the curriculum and to better monitor the impact of career-related learning (Hughes & Kashefpakdel, 2019). Supplementary research with professional school counsellors and career advisers has similarly indicated the need for further training in designing and implementing career-related activities in classroom settings (Anctil et al., 2012).

The practical issues hitherto mentioned have presented schools, teachers, career practitioners, and other career stakeholders with various opportunities and challenges over recent decades. However, it is possible that as automation and job change accelerates the composition and complexity of these practical opportunities and challenges are likely to change in important ways (Hirschi, 2018; Lent, 2018). A growing complexity has been cited in interviews with school leaders in the UK. Recent research found the interviewees reported a general lack of awareness and need for training on current and future trends in the labour market (Hughes & Kashefpakdel, 2019; Kashefpakdel et al., 2019). This points to possible conceptual and practical difficulties career education stakeholders may face in addressing automation and job change with children.

Some of these issues may include the difficulty of achieving a close correspondence between the organised career learning activities and the available job opportunities or characteristics of occupations as they undergo significant change. For instance, to help children prepare for jobs in the technology sector, career stakeholders may increasingly need to facilitate learning of social skills and tasks which are growing in prominence (Colombo et al., 2019; World Economic Forum, 2020). Stakeholders may also find it more difficult to secure career role models or workplace learning experiences that closely resemble future job opportunities available to children. Identifiable career models and realistic workplace learning scenarios are recognised as important for children's learning through observation and imitation (Bandura, 2001; Bandura et al., 2001).

Accelerating and unpredictable changes occurring in the world of work may also create more uncertainty, anxiety, and added cognitive demands for young people to rationally process a growing array of career information (Ginevra & Nota, 2018; Lent & Brown, 2020; WorldSkills & OECD, 2019). Additionally, supporting children and adolescents to develop career supports and barrier coping strategies may become more difficult as the supports needed to pursue and prepare for a preferred career (e.g., career networks, training opportunities) may be increasingly subject to change.

2.7.3.1 New conceptual and practical challenges facing stakeholders

Up to this point it has been shown that career education provisions can be organised and shaped by a range of stakeholders (e.g., schools, families, policymakers etc.) and that these provisions can contribute to children's career development and preparedness. While support for children's career development has been important in various ways (e.g., to reduce children's narrowing of career options, build career knowledge and adaptability), career provisions and stakeholders could face

emerging problems as accelerating automation creates new career risks which may impact children and different groups. Yet, there is reason to believe that addressing automation and job change with children could present a range of conceptual and practical challenges/opportunities for existing career provisions and stakeholders. On the conceptual side, significant complexity and variation in recent predictions of the future extent of job automation may make it difficult to effectively design career policy and practice. By acting on false predictions about the future of automation, policymakers and practitioners could inadvertently dissuade children from jobs they may otherwise have achieved success in.

From a practical perspective, accelerating job change could make it more complex to identify relevant career role models, manage children's career uncertainty, and plan workplace or career learning experiences that closely resemble future occupational requirements or job opportunities available to children. Despite the possibility for these new conceptual and practical issues to impact career education provisions with children, to date little empirical research has been dedicated to examining the complexities of implementing career education provisions to support children in preparing for a changing world of work (Watson & McMahon, 2022). Research into these complexities can help different stakeholders make more informed decisions to support children's career preparedness for the emerging risks associated with automation. Because these conceptual and practical complexities are likely to vary depending on the context and stakeholders involved, it is important to critically examine the perspectives of different stakeholders who contribute to children's career education. By analysing emerging conceptual issues and practical challenges/opportunities in a specific context, it is possible to improve career policy

and stakeholder practice in support of children's preparedness for automation and job change.

2.8 Summary statement of the problem

Overall, this literature review has revealed several distinctive aspects of a problem that is likely to affect children and adolescents as future workers and career choice makers, along with those that support them in developing their career aspirations and preparedness. The first relates to the issue that because automation may impact various occupational tasks and certain job types more than others, children could encounter new and differential automation-related career risks (e.g., unemployment, skill gaps, financial loss) that merit investigation. The second, stemming from the first, concerns the issue that existing career aspiration intervention approaches, which may often draw on traditional person-occupation matching processes, may not address the nuanced job changes and risks associated with automation. Thus, there is reason to critically examine recent intervention approaches to gain insights and identify gaps in how children's and adolescents' career aspirations are supported for the rapidly changing world of work.

The third aspect of the problem, following on from the previous two, involves the potential for accelerating job change to present new conceptual and practical challenges for different career education stakeholders while supporting children's career preparedness. By examining the conceptual issues and practical challenges/opportunities of addressing automation and job change in a specific context, it is possible to advance career policy and stakeholder practice in support of children's preparedness for the changing world of work. To investigate this problem and its distinctive aspects, the following overarching research question was addressed: what are the complexities of supporting children's career aspirations and

preparedness for automation and job change? The next section explains how the three research studies to follow address the different aspects of the problem.

2.8.1 Multi-study approach

This chapter has discussed how multiple career transitions and more wide-ranging job automation could present new theoretical and practical complexities for supporting children's career aspirations and preparedness. First, because automation may affect certain types of occupations and tasks more than others, and since various groups of young people tend to pursue specific job types, there is reason to believe that different groups may encounter differing automation-related career risks. To investigate this problem the first study in this thesis estimated and analysed differences in the automation-related career risks various groups of school students may encounter. Based on the analysis carried out in Study One, there was evidence to suggest that certain groups of school students may be more likely to aspire to occupations at risk of automation over the coming decades (Sowa et al., 2022).

Because the identified risks are complex (i.e., with some high status, non-routine, as well as routine jobs at risk of automation) and depend on the realisation of various socio-economic factors, they necessitated a cautious response. Given the uncertainty in predicting automation and future job markets, conducting career aspiration or choice interventions to shift choice makers from high-risk occupations to low-risk occupations could create problems (Lent, 2018). Such interventions may, by acting on false predictions, unintentionally redirect young people or adults away from occupations they could have otherwise attained and achieved success in.

There nonetheless remains potential value for interventions to use relevant information and insights about automation (e.g., occupational skill and task changes)

to support young people's career aspiration development without necessarily dissuading them from occupations predicted to be at risk of automation (Lent, 2018). Yet, commonly used intervention approaches to support young people's career aspirations/choices, which may often incorporate traditional person-occupation matching processes, may not effectively address accelerating job change and the risks associated with automation (e.g., differential impacts across groups).

Because of the possible complexities in supporting children's career aspirations within the context of accelerating automation and job change, it was important to critically examine how recent career aspiration interventions have addressed the changing conditions underlying careers. To gain insights and identify gaps in recent career aspiration intervention approaches, the second study systematically reviewed how recent career aspiration intervention studies involving children and adolescents have/have not addressed job change and the risks associated with automation.

Results from Study Two revealed that recent intervention approaches have largely not, through their objectives or learning content, addressed changes within occupations or job markets (Sowa et al., 2023). Consequently, this identified gap raised the issue of the potential opportunities and challenges of implementing career education provisions with a focus on automation and job change. Some of these challenges may relate to practical difficulties identifying relevant career role models, providing career learning experiences that closely correspond to future job opportunities and occupational skill requirements, as well as conceptualising the complex and differential impacts of automation in career policy.

Such challenges and opportunities concern the various stakeholders who contribute to children's career education, including policymakers, career practitioners, and teachers (Taveira et al., 2017). As the conceptual/practical opportunities and

challenges of supporting children's preparedness for the changing world of work are likely to be context dependent and involve multiple stakeholders, it was beneficial to explore the perspectives of different stakeholders who contribute to children's career education. For these reasons, a case study of the Scottish career education system was the focus of the third study. This included an analysis of career education stakeholders' perspectives on addressing automation and job change with children. Study Three examined various conceptual and practical challenges faced by Scottish career policymakers, practitioners, and teachers, and revealed insights into how stakeholders may support children's career preparedness for the changing world of work. Following a synthesis of the findings from the three studies, this thesis was able to provide recommendations for advancing career theory and practice. Implications were also specified for different stakeholders as they pertain to supporting children's career aspirations and preparedness for automation and job change.

2.9 Research questions

The overarching aim of this thesis was to contribute to an understanding of the complexities of supporting children's career aspirations and preparedness for the changing world of work. To address distinct aspects of the problem three sequential and interrelated studies were carried out. Each of these studies addressed a specific research question(s). These research questions are presented below.

Study One

- 1) What differences exist among school students and various subgroups in aspiring to occupations at technical risk of automation over the next few decades?

Study Two

- 1) In what ways are the approaches used in career aspiration intervention studies involving children and adolescents addressing changing career conditions?
- 2) What tensions and gaps exist between career aspiration intervention approaches and the changing career conditions?

Study Three

- 1) How do policymakers and practitioners involved in children's career education conceptualise automation and the changing world of work?
- 2) What practical opportunities and challenges do career education stakeholders face in supporting children's preparedness for automation and job change?

3.0 Study One: Analysis of Automation-Related Career

Risks

3.1 Chapter overview

This chapter details the first study in this thesis. Proceeding on the informed basis that future automation may differentially impact occupations and that various groups of young people tend to aspire to different types of occupations, the following research question was addressed: what differences exist among school students and various subgroups in aspiring to occupations at technical risk of automation over the next few decades? Survey data covering the career aspirations of British primary and secondary school students were combined with probability statistics on job automation and analysed using ANOVA techniques. Findings from the study were interpreted and discussed through the framework of SCCT. Results indicated that students aged 13 years old and above were more than twice as likely to express an occupational aspiration associated with a high risk of automation, along with a larger proportion of male students, lower socio-economic groups, and respondents knowing someone (particularly a parent) holding their desired occupation ($P < .05$).

Implications for career theory and practice were subsequently discussed. This study was published as an open access article in the International Journal of Educational and Vocational Guidance.

3.2 Introduction

The opening chapters in this thesis highlighted how automation has and may increasingly impact occupations and job tasks – raising new implications for children's career pursuits (i.e., career-related activities and choices). Much of the job automation occurring over the past few decades has been concentrated in the

manufacturing sector and several other routine-intensive occupations and tasks (Autor, 2015; Charles et al., 2013). However, recent developments in artificial intelligence, machine learning, and mobile robotics are enabling technologies to perform a growing number of routine as well as some non-routine manual and cognitive tasks (Brynjolfsson & McAfee, 2014; Frey & Osborne, 2017; Schwab, 2017). The accelerated development and integration of these new digital technologies has the potential to bring cyber and physical systems together in more complex ways (Rajkumar et al., 2010). Because of the exponential speed of technological advancement and the reducing costs of microprocessors (Atkinson, 2014), some argue that the necessary conditions are now in place for new technologies to substantially reshape workplaces, employment, and societies over the coming decades (Brynjolfsson & McAfee, 2014; Schwab, 2017).

As a contrast to these viewpoints other scholars have raised questions about the likely extent of future job automation (Acemoglu & Restrepo, 2020; Arntz et al., 2017; Morgan, 2019). It has been pointed out that past predictions of mass unemployment failed to be realised partly due to underestimates of the number of new jobs created through gains in productivity and the new occupations branching off newly automated roles (Autor, 2015; Morgan, 2019). Some have also noted that experts have at times overestimated the capacity of new technologies, such as previously overstating the comparative advantage of machines in performing tasks requiring flexibility and judgement capabilities (Arntz et al., 2016; Autor, 2015).

Though the future extent of job automation remains subject to ongoing debate (Arntz et al., 2017; Frey & Osborne, 2017), the novel possibility for both routine and some non-routine manual and cognitive occupational tasks to be automated has potentially important consequences for different groups which merit further study. Estimating

the potential impact of job automation on different adult groups, Madgavkar et al. (2019) concluded that a comparatively greater proportion of male workers may encounter increased risks in retaining existing jobs over the coming decades. The main reason for this relates to male workers occupying the vast majority of highly automatable manual labour-intensive occupations and comparatively fewer roles in industries less susceptible to automation. Lower socio-economic groups and young people may encounter increased risks in pursuing or attaining jobs due to more entry level, low-paying, and lower-skilled occupations becoming more susceptible to automation (Frey & Osborne, 2017; OECD, 2018).

Because it may take at least a decade or two for new technologies to appreciably affect job markets (Frey & Osborne, 2017), present and future generations of children and adolescents could be significantly affected as rapid changes to occupations and skill requirements may coincide with their important educational and career decision making milestones. A considerably altered landscape of work could create new career risks for current and future generations of children as they pursue and attain different types of occupations affected by automation. These opportunity costs or career risks, while difficult to quantify, may include possible job loss or periods of unemployment in some cases, as well as skill gaps, lost time, inadequate career-related networking, and misspent financial expenditure spent preparing for and pursuing/attaining an occupation(s) affected by automation (Lent, 2018; Lent & Brown, 2020; Mann et al., 2020).

Providing information on the ongoing impact of technology on job markets and occupational requirements could benefit many current and future workers in avoiding various career difficulties (Lent, 2018; Mann et al., 2020). So far, the implications of job automation for children's and adolescents' educational and career pursuits have

received little empirical investigation in the career development literature (Hirschi, 2018; Lent, 2018). This study contributes to an understanding of the differences in automation-related career risks across different groups of school students and furthers the discussion of the emerging ramifications of occupational change for career interventions and theoretical developments. To inform an investigation into these career risks it was important to identify and critically examine models predicting future job automation. This is carried out in the next section.

3.2.1 Estimating future job automation

In attempting to estimate the future extent of job automation across multiple countries various studies have produced differing results. Some studies estimate approximately 30%-47% of jobs could be highly susceptible to automation (Frey & Osborne, 2017; PwC, 2018), while others estimate the figure is closer to 9%-14% of jobs (Arntz et al., 2017; OECD, 2018). These study results differ partly because they employ slightly modified ways of calculating technological adoption time lags and the proportion of tasks within occupations that could be impacted by automation. Though these studies report different estimates of the percentage of occupations that could be entirely replaced by machines, they all indicate that the increasing adoption of new technologies are likely to significantly change the task composition of many occupations. This makes automation an important issue for career theory and practice irrespective of whether entire occupations are automated or not. Because the above-mentioned studies derive in large part from the model produced by Frey and Osborne (2017), it was valuable to consider this model and its potential limitations.

To estimate which present-day occupations could be more susceptible to automation based on the capability of current technologies, the researchers formulated a model

to account for likely technical barriers or bottlenecks (Frey & Osborne, 2017). These technical bottlenecks concern the difficulty technologies have in performing tasks involving creativity, social intelligence, and perception and manipulation in unstructured environments. To calculate automation/computerisation probability values for 702 occupations, a broad range of technology experts were first brought together at Oxford University to collectively assign probability values to a sample of 70 occupations. These computerisation probability values were calculated with consideration of the tasks within each occupation as they relate to the different technical barrier/bottleneck variables. An algorithm was subsequently devised to replicate the initial categorisations and to produce probability values for 632 additional occupations.

Using the probability values various economic sectors were identified as containing proportionally more occupations at medium or high technical risk of automation (probability > 0.30) over the next few decades. These sectors included: transportation and material moving; production; installation, maintenance and repair; construction and extraction; farming, fishing, and forestry; office and administrative support; sales and related; and service (Frey & Osborne, 2017, p. 267). Larger proportions of manual labour-intensive occupations and low-skill and low-wage roles across multiple sectors were projected to be more susceptible to automation. Occupations estimated to be at lower risk of automation included those in education, healthcare, computing, engineering, science, legal, community service, arts, media, management, business, and financial sectors (Frey & Osborne, 2017, p. 267). These lower-risk occupations are thought to contain more non-routine tasks requiring originality, capabilities in the fine arts, negotiation, persuasion, social perceptiveness, and/or assisting and caring for others.

Models predicting job automation have provided useful insights on the types of occupations and skill requirements that could be more or less prevalent in the near future. But it is nonetheless important to clarify some of the methodological limitations. The algorithm used to compute most of the probability values was designed to reproduce the smaller sample of predictions generated by the technology experts. Because of this approach there remains uncertainty over whether the subjectively derived predictions of the technology experts are sufficiently accurate (Arntz et al., 2017; Morgan, 2019). In addition, rather than assigning probability values to whole occupations, assigning probability values to individual or collections of tasks within each occupation could have been a more reliable way to estimate the future consequences of automation (Arntz et al., 2017; Autor, 2015).

As well as possible methodological issues, a range of social and economic factors will influence the adoption of new technologies in workplaces. Research suggests new technologies such as humanoid service robots could be limited in their uptake due to consumers' possible experiences of discomfort when interacting with the machines (Mende et al., 2019). Many economic factors will likely impact companies adoption of new technologies, including: the costs associated with developing and implementing new technological solutions; general supply and demand trends for human labour; the amount of profit obtained through labour cost savings and the returns gained through selling a higher quantity or quality of goods and services; and regulatory barriers limiting the adoption of new digital technologies (Arntz et al., 2016; Manyika et al., 2017; Mokyr et al., 2015).

Even with these potential limitations, the model produced by Frey and Osborne (2017) has been pivotal in the field of job automation (with over 12,000 citations on Google Scholar). It has allowed researchers to forecast the types of jobs and tasks

most likely (from an engineering/technical standpoint) to be subject to automation over the coming decades and to assess employment risk differences across groups (Fuei, 2017; Hoff et al., 2022). Use of this model also makes it possible to investigate automation-related career risks across different groups, including primary and secondary school students, who have received limited empirical study (Hoff et al., 2022). Findings from this career risk analysis can potentially provide important insights to inform career development theory and practice with young people. To assess school students' automation-related career risks, a reliable predictor of their future educational and career pursuits and attainments was needed. This predictor is explored in the next section.

3.2.2 Career aspirations as predictors of occupational pursuits

A career or occupational aspiration has been defined as an "individual's expressed career-related goal(s)" that refers to attaining a specific occupation(s) or a job in a particular occupational field(s) (Rojewski, 2005, p. 132). Career aspirations reflect a person's career-related goal(s) given ideal conditions. In comparison, career interests reflect a person's emotional disposition toward different occupational options (Nikel, 2021; Rojewski, 2005). Results from several studies show adolescents' career aspirations are a strong predictor of the occupations they pursue and attain in adulthood (Cochran et al., 2011; Schoon, 2001; Strong, 1953). For instance, research by Schoon (2001) reported that the career aspirations expressed by British students at age 16 were significantly associated with their occupational attainment at age 33. This included over 50% of participants expressing aspirations for, and then obtaining jobs in the natural sciences and healthcare fields. When compared with career expectations, adolescents' career aspirations have been found

to be similarly or more associated with their career-related activities and attainments (Beal & Crockett, 2010; Saha & Sikora, 2008; Whitney, 1969).

Relative to adolescents' career aspirations, pre-adolescent children's career aspirations are thought to be less predictive of their future occupational attainments. Some have claimed that the occupational aspirations expressed by primary school students are likely to change over time and generally do not provide a reliable indication of their future occupational choice (Gore et al., 2017). In contrast other scholars have argued that primary school students' occupational aspirations are more stable than historically assumed (Chambers et al., 2018; Hughes & Kashefpakdel, 2019). Research suggests over short and longer time spans primary school children's career aspirations are moderately stable at the individual level, but more predictable in the aggregate. A longitudinal study conducted in the USA using panel data reported that most participants aged 8 years old (87%) expressed career aspirations which remained unchanged across a 9-month period (Trice, 1991).

Additional longitudinal research carried out in the USA using panel data found relatively small proportional changes in students' aspirations from primary school to the end of secondary school (Helwig, 2003). Monitoring changes in the career aspirations of 65 students from second to twelfth grade, at both time points similar proportions were found to hold career aspirations in the social (34% versus 38% respectively), investigative (25% versus 20%), and enterprising (20% versus 15%) categories. Slightly larger changes were evident in the artistic (12% versus 5%) and conventional job categories (2% versus 12%) (Helwig, 2003, p. 27).

A recent comparative study of separate large-scale survey results involving over 10,000 British primary school students (aged 7-11) (Chambers et al., 2018) and

comparable numbers of British secondary school students (aged 13-18) (Mann et al., 2013) reported similar typology proportions in students' career aspirations (Rogers et al., 2020). While noticeably more students aged 7-8 expressed career aspirations in the art, culture, entertainment, and sports sectors compared with those aged 17-18 years old (44% and 16% respectively), in most other sectors (13 out of 16) similar proportions were evident for both age groups (Rogers et al., 2020, pp. 8-9).

This body of evidence provides several insights into the stability and predictive value of children's and adolescents' career aspirations. The career aspirations of adolescents may be used, with a fair degree of accuracy, to predict their future occupational attainments (Schoon, 2001). While the career aspirations of primary school children are less stable at the individual level, when considered in the aggregate, such as the type of occupational aspiration expressed, they can serve as a reliable indicator of school students' career pursuits/attainments. Therefore, by using a sufficiently large and representative sample of school students' career aspirations, combined with a model of job automation, it is possible to estimate differences in the automation-related career risks of various groups of school students (Hoff et al., 2022). Next, to understand how children's career pursuits and automation-related risks may vary, insights were drawn from theories of career aspiration development.

3.3 Theoretical perspectives on career aspiration development

To explain how children develop their career aspirations, Gottfredson (2002) devised a theory incorporating concepts of career circumscription and compromise. The theory suggests children between the ages of 3-5 become increasingly aware of the realities of adulthood, developing schemas about adulthood and what holding an occupation involves, and how they might take on roles themselves in the future.

From the ages of around 6-8 years old, children begin categorising careers based on perceived sex roles. Careers perceived as unsuitable for their gender identity are then excluded or circumscribed from further consideration. Another phase of circumscription is thought to occur between the ages of 9-13 as children orient themselves towards social valuation, resulting in the exclusion of career options perceived as below and above their social status. As children progress into adolescence (around age 14) they orient more towards their internal, unique self-conception. Drawing on their self-understanding children tend toward career options that personally interest them and that have not already been previously circumscribed based on the perceived attainability of the career and criteria such as those relating to gender and social prestige (Gottfredson, 2002).

As a complement to the Theory of Career Circumscription and Compromise, research indicates other psychosocial constructs can help predict children's career aspirations and pursuits (Baker et al., 2014; Gore et al., 2015). To integrate these additional constructs and provide a unifying framework for explaining children's career pursuits SCCT was used. SCCT specifies that a person's prior learning experiences, as mediated by their personal inputs and environmental affordances, influence the development of their self-efficacy beliefs and outcomes expectations, these beliefs in turn shape a person's career-related interests, goals, and choices (Lent & Brown, 2019). Near choice making junctures a person may also experience perceived and/or actual barriers and supports which influence the development of their career aspirations and implementation of their career choices (Lent & Brown, 2019; Sheu & Bordon, 2017). In this way supports and barriers related to automation and changing job markets may contribute to the occupations individuals decide to pursue and/or attain (Hirschi, 2018). The following section briefly revisits several key

personal and environmental factors affecting children's career aspirations and pursuits.

3.4 Literature review

3.4.1 The influence of gender and parents on children's career aspirations

Gender has been found to be moderately predictive of children's career aspirations across many country contexts (Chambers et al., 2018; Gore et al., 2015; Nikel, 2021). Average gender-based differences for people-centred versus thing-centred occupations have been found in studies involving primary school students from the UK and 19 additional countries, as well as American students between the ages of 13-16 (Chambers et al., 2018; Howard et al., 2011). On average more females expressed aspirations for occupations involving substantial interaction with people (e.g., nurse, hairdresser). While male students more often expressed career aspirations for working with things/objects (e.g., builder, engineer). There is a growing body of evidence from the USA and the UK suggesting a higher proportion of female students may express aspirations for higher prestige occupations and jobs requiring higher levels of education than male students (Chambers et al., 2018; Howard et al., 2011). Female students' greater propensity toward people-centred and higher-status careers may indicate that fewer female students will aspire to occupations which are highly susceptible to automation, such as manual labour roles or lower status jobs (Frey & Osborne, 2017).

Parents can also contribute to children's career aspirations through encouragement, values sharing, and behaviour modelling (Liu et al., 2015). Research exploring the career aspirations of students aged 12 found that those expressing high status career aspirations and expectations frequently had parents who expressed high status occupational aspirations and expectations for their children (Creed et al.,

2007). A moderate association between children's career aspirations and their parents' actual occupations has been reported in studies involving primary school students (Kintrea et al., 2011; Trice & Knapp, 1992). Because children's career aspirations can sometimes align with their parent's occupation, there is reason to suggest that school students with parents who hold higher-risk occupations could be more likely than their peers to express higher-risk career aspirations.

3.4.2 The influence of socio-economic background on children's career aspirations

The socio-economic environment a child is raised in can additionally shape their career aspirations. Moulton et al. (2018) carried out research involving British children aged 7. They found that after controlling for relevant variables, high status career aspirations were more likely to be expressed by children from higher socio-economic backgrounds than children from lower socio-economic backgrounds. Similar effects of socio-economic background have also been reported across British ethnic minority groups. British female ethnic minorities from high socio-economic backgrounds expressed higher career aspirations than their counterparts from lower socio-economic backgrounds (Gutman & Akerman, 2008).

Even though children's socio-economic background has been frequently reported as a factor influencing their career aspirations, several studies suggest the effect size might be small compared to other variables (Baker et al., 2014; Gore et al., 2015). For example, Gore et al. (2017) conducted a multivariate analysis of the occupational aspirations of over 6000 students (aged 8-18) from 64 schools in Australia and found variables such as school location, indigenous status, and socio-economic status were weaker predictors of participants' aspirations than were gender, school year, and prior achievement. Whilst potentially small, differences in

career aspirations across socio-economic groups may nonetheless mean that proportionally more lower-income school students could aspire to occupations at higher risk of automation, such as low-wage or low-skilled roles (OECD, 2018).

3.5 Research rationale and goal

It has been shown how children's career aspirations are influenced by different personal and environmental factors. These factors can lead various groups of children to pursue different types of occupations. Empirical and theoretical insights suggest higher proportions of adolescent school students hold aspirations for occupations classified as conventional or realistic. Children with parents holding lower-status jobs are more likely to express comparable career aspirations. Male students are more likely to express aspirations for manual labour-intensive roles. School students from lower socio-economic backgrounds are more likely to hold aspirations for lower status/wage occupations. Based on these insights there was reason to conjecture that these groups of school students could be more likely to aspire to occupations at higher technical risk of automation. This is because proportionally more routine, manual-labour intensive, and low status/wage occupations are predicted to be highly susceptible to automation (Frey & Osborne, 2017). For these reasons four hypotheses were formed:

- 1) adolescent school students are more likely to express aspirations for occupations associated with a higher technical risk of automation
- 2) school students with parents holding occupations at high technical risk of automation are more likely to express higher-risk aspirations
- 3) male students are more likely to express aspirations for occupations associated with a higher technical risk of automation

4) students from lower socio-economic backgrounds are more likely to express aspirations for occupations associated with a higher technical risk of automation.

Within the framework of SCCT, supports and barriers from automation and changing job markets can be relevant factors influencing the occupations children pursue (Lent, 2018; Lent et al., 2000). Evidence from several studies suggests young people consider new trends in the economy and technology as important for their career decision making (Mbilini et al., 2019; McDevitt et al., 2013). Yet, many young people have indicated they believe it could be more difficult to secure a job in the coming decades due to automation and changing job types (Speakers for Schools, 2018; WorldSkills & OECD, 2019). Because many school students and different subgroups may face emerging barriers from automation and occupational change, as well as potentially limited personal resources to navigate these barriers (actual and perceived), it was important to examine school students' automation-related career risks. If left unexamined and/or unaddressed, these career risks or opportunity costs could contribute to unemployment or job loss in some cases, as well as misspent time, skill gaps, and financial expenditure spent preparing for and pursuing/attaining occupations affected by automation.

This study set out to address the following question: what differences exist among school students and various subgroups in aspiring to occupations at technical risk of automation over the next few decades? Through this investigation into primary and secondary students' career aspirations and the associated technical probabilities of automation, there was scope to inform career research and practice. Results could be used to develop more targeted interventions based on children's evolving career

risks and opportunities. They can also aid school students and different subgroups in navigating automation-related career barriers and building relevant supports.

3.6 Methods

A secondary data analysis was undertaken to address the research question. This approach comprises of an empirical exercise carried on qualitative and/or quantitative data that has already been compiled (Johnston, 2017; Smith, 2012). An important benefit of this approach is that it enables a researcher to make use of large pre-existing datasets, which, due to resource and time constraints, can be more challenging to obtain via primary data collection methods (Donnellan & Lucas, 2013; Smith, 2012). For the purposes of this Study Three pre-existing datasets were used. Two of these datasets cover the career aspirations of British primary and secondary school students and their demographic information, along with another dataset containing probability statistics on job automation. By combining these large quantitative datasets, it was possible to make more generalisable inferences about differences in automation-related career risks across age and demographic variables of British school students.

3.6.1 Dataset selection and appraisal

The first dataset was selected on the basis of being one of the largest and most recent surveys of British primary school students' career aspirations. The dataset also included respondents from 19 additional countries. This large dataset was selected to represent the career aspirations of contemporary British primary school students and various subgroups more accurately (i.e., different regions, socio-economic groups, genders, ages). When selecting and appraising the relevance and quality of a dataset is it important to inspect the data files for missing or erroneous data entries and to review the procedures used to generate the dataset (Donnellan &

Lucas, 2013; Smith, 2012). Raw anonymised survey data files were obtained from the lead research partner, Education and Employers, following email communications. The data was inspected for missing or inaccurately recorded data. The survey responses were collected in 2017 and subsequently presented in a report published in 2018 (Chambers et al., 2018).

Discounting unidentifiable responses, the dataset contained 11,786 responses from primary school students between the ages of 7-11. Students were recruited from 146 primary schools across 12 regions of the UK (including the Isle of Man) based on a stratified sampling technique. When compared against the demographic data for the entire primary school student population in 2017 (Department for Education, 2017), the sample was broadly representative of the regional, gender, age, and ethnic makeup of the country's primary school children. However, students from Northern Ireland were significantly underrepresented. Respondents from independent and fee-paying schools were also slightly underrepresented (1% versus 3% of entire student population) (Department for Education, 2017). As the primary school student population was approximately 3.8 million in 2017 (Department for Education, 2017), a 95% confidence level and 0.9 confidence interval were approximately attained with a sample size of around 11,800. A more detailed numerical breakdown of the sample and student population demographics is provided in Appendix B. A link is provided at the end of this study to a data repository in which the entire raw data, data analysis, and demographic information are accessible.

Survey responses from the non-British respondents (5848 primary school students from 19 other countries) were not reported in this study due to the insufficient sample size for each participating country. Most countries had less than 500 respondents each. There was thus a high probability that these samples did not reliably reflect the

career aspirations of the wider population of primary school students in each country (Smith, 2012).

A standard format was used to collect the career aspirations and demographic data from the primary school student respondents. All student respondents were given a pre-prepared questionnaire by their teachers. On this form students were invited to draw a picture and write down the name of the occupation they want to hold when they are older. Students were also asked to specify whether they personally knew someone who held the occupation they drew, and if not, how they knew about the job. Demographic information was collected from the students and the teaching staff. The career aspirations expressed by the respondents were coded into a list of 69 occupations specified in the UK Commission for Employment and Skills' occupation data repository (Chambers et al., 2018).

To approximate the socio-economic status of the respondents, information was gathered on the percentage of students eligible for Free School Meals (FSM) within each school participating in the survey. This information was used as an indicator to differentiate student respondents from lower socio-economic backgrounds (21%-50%+ FSM eligibility) with those from higher socio-economic backgrounds (0-20% FSM eligibility). Recent research suggests FSM eligibility can be a reliable proxy for identifying socio-economically disadvantaged students (Taylor, 2018). However, as the data collection approach taken in Chambers et al. (2018) research measured FSM eligibility at the school level rather than the eligibility of individual respondents, this measure has the potential to overestimate or underestimate the number of respondents eligible for FSM. Considering the possible limitations of the FSM eligibility data used in this study, more caution was taken in interpreting any socio-economic risk differences as statistically significant.

In addition to the dataset for primary school students, a separate dataset was used in conjunction with this dataset to incorporate secondary school students' career aspirations within the analysis. In this dataset responses were obtained from 10,729 secondary school students (discounting ineligible responses). These were obtained via a questionnaire in which students were asked to record their career aspirations. Responses were collected in March-April 2012 from English secondary school students aged between 13-18 years old. The survey was carried out by the b-live Foundation and was subsequently included in a report published in 2013 (Mann et al., 2013). Data were broken down by age groups, but additional demographic information was not available for this dataset. Respondents were, however, broadly representative of the national secondary school student population with respect to different school types (74% comprehensive, 5% independent, 8% grammar, and 13% other school/college types) (Mann et al., 2013).

As the size of the secondary school population was approximately 2 million students in 2012 (Department for Education, 2012), a 95% confidence level and 0.9 confidence interval were nearly attained – requiring a sample size of around 11,790. A more detailed numerical breakdown of the sample and secondary school student population demographics is provided in Appendix B. Respondents' career aspirations were coded in an identical way to the approach used for the primary school student respondents. Because the two datasets refer to different student cohorts and are therefore not a form of panel data, the results reported in this study are not a reflection of the development of individual school students' career aspirations over time. However, because the two datasets are relatively large, recent, and broadly representative of the primary and secondary student

populations, they provide a useful aggregate level overview of the career aspirations held by contemporary British school students across different year groups.

To estimate the automation-related career risks school students' may encounter in pursuing their career aspirations, a supplementary dataset was used. This contained probability statistics on future job automation. The probability figures were generated from the model developed by Frey and Osborne (2017). The model was developed to estimate the technical likelihood of presently existing occupations being susceptible to computerisation (i.e., from an engineering standpoint only). Using this model a list was produced of 702 occupations and their respective probability (between 0-1) of computerisation (Frey & Osborne, 2017, pp. 269-278). The benefits and limitations of this model were discussed in more detail in Chapter 2. To summarise, the main benefit of using the probability statistics was to enable an analysis of the automation-related career risks school students may encounter based on estimates generated by a range of technology experts. These probabilities have been valuable for researchers in estimating the types of occupations which are more susceptible to automation over the coming decades (Fuei, 2017; le Roux, 2018).

3.6.2 Procedure

The three datasets were analysed using Excel and SPSS. After listing the discrete occupations expressed as career aspirations by the primary and secondary school student respondents, the corresponding job computerisation probability value, specified in the dataset produced by Frey and Osborne (2017), was paired with each occupational aspiration. In instances where a precise match between a distinct occupational aspiration and one of the 700 occupations with a computerisation probability value was not possible, one of two courses of action were undertaken. When a closely related alternative(s) to the occupational aspiration was available

(e.g., physicists, chemists, and biologists closely matched the career aspiration of scientist), the single alternative or the mean probability value of multiple closely related alternatives was used. The median rather than the mean probability value was used in cases where multiple alternatives had a skewed distribution.

When there was no closely related alternative to match with the career aspiration (e.g., celebrity, social media and gaming, astronaut, politician), no probability value was assigned. Less than 7% of respondents expressed career aspirations that could not be assigned a computerisation probability value (6 out of 70 distinct occupations). However, because these occupations contain a high number of constituent tasks requiring significant creativity and/or social intelligence, they are likely to be at low risk of automation and would therefore not have impacted the calculated proportion of higher-risk career aspirations. Each distinctive occupational aspiration was also labelled with a Holland Occupational Theme (e.g., Realistic, Investigative, Artistic, Social, Enterprising, and Conventional). These relate different personality types to specific occupations and career environments (Holland, 1996).

3.6.3 Data analysis

Both descriptive and inferential statistics were used to describe and analyse the data. For the different subgroups of school students (i.e., age groups, gender, parental occupation, ethnicity, and eligibility for FSM), the proportions of survey respondents expressing aspirations for each distinct occupation were calculated. Thereafter for each subgroup the percentage of respondents expressing low risk career aspirations (probability ≤ 0.33), medium risk career aspirations (probability > 0.33 and < 0.66), and high-risk career aspirations (probability ≥ 0.66) were summed. The decimal thresholds for low, medium, and high closely correspond to those employed by Frey and Osborne (2017) and provide an approximate means by

which to classify the automation-related risk levels of different career aspirations. In the low-risk category 37 distinct occupations were expressed as aspirations. While 10 occupations were expressed as aspirations in the medium risk category, and 17 occupations were expressed as aspirations in high-risk category.

As well as calculating descriptive statistics (e.g., mean and standard deviation values), an analysis of variance (ANOVA) was carried out to test for differences in the probability of automation associated with career aspirations expressed across age, gender, ethnicity, socio-economic status, and respondents' parental occupation. SPSS was used to estimate between-subjects effects, including significance, partial eta squared, and observed power values for the different independent variables. The benefit of using this analysis method was to help determine whether the variability in respondents' aspirations for occupations associated with a specific probability of automation could be reasonably attributable to one or multiple independent variables.

3.6.4 Ethical considerations

Prior to receiving the raw survey data on school students' career aspirations from the lead organisation responsible for conducting the survey, the organisation took steps to anonymise the data included in the shared Excel file. After receiving the raw anonymised data, the lead researcher carried out a further inspection of the data to ensure no personally identifiable information was present (Johnston, 2017). This raw data was stored on a secure data storage system (password protected University of Edinburgh OneDrive account) in accordance with the ethical guidance set out by the Moray House School of Education and Sport Ethics Sub-Committee. Ethical guidance provided by the British Educational Research Association (BERA) was also followed during this study. The probability statistics used in this study from the

published work of Frey and Osborne (2017) remains publicly accessible and did not raise any additional issues of confidentiality.

3.7 Results

3.7.1 Age differences in automation-related career risks

Results from the secondary data analysis provide support for the first hypothesis. A significantly larger proportion of secondary school students expressed aspirations for occupations at medium and high technical risk of automation compared to students in primary school. Approximately 7.4% of British primary school students (aged 7-11) expressed aspirations for occupations at medium and high technical risk of automation. There were relatively small differences between children aged 7-8 (6.4%) and 9-11 years old (8.3%). However, for students only a few years older in the early years of secondary education, this figure nearly triples to 20.6% for those aged between 13-14 years old. Incremental increases in secondary school students' career pursuit risks were evident for those aged 15-16 (22.2%) and 17-18 years old (25%). These automation-related career risk differences across age groups are presented in Figure 3.

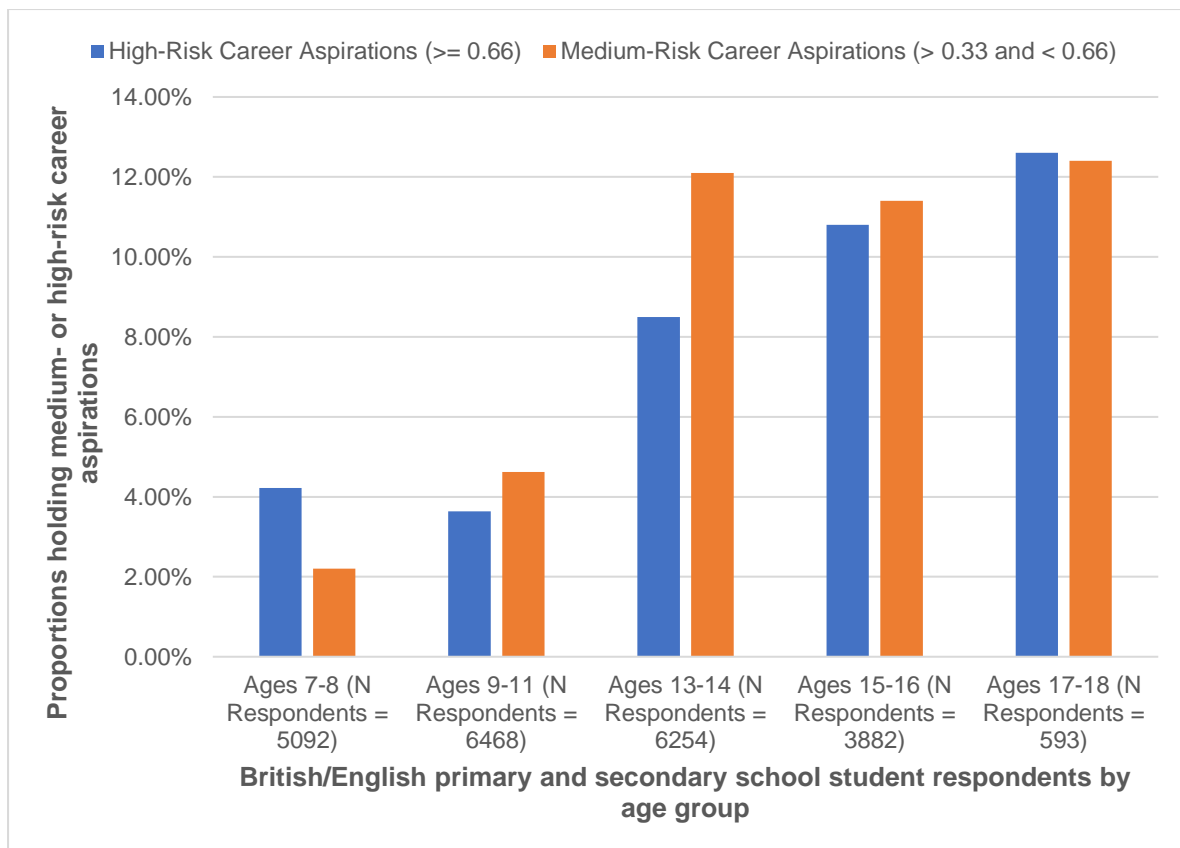


Figure 3 Proportions of British primary and secondary school students aspiring to occupations at medium or high technical risk of automation

ANOVA results indicate primary and secondary school students' age was found to be a statistically significant independent variable explaining aspiration risk differences, $p < .001$, power = 1.0, and $\eta^2 = .010$. The effect size for this variable is classified as small. Differences across the primary and secondary education divide are largely attributable to the lower proportion of secondary school students aspiring to occupations in the sport, entertainment, culture, and arts sectors in favour of occupations from a diversified range of sectors. For example, career aspirations in the Conventional category (e.g., accountant and office admin/receptionist), which has proportionally the most occupations at high risk of automation, increased from 0.39% to 7.10% between the age groups of 7-8 to 17-18 years old. Although some of the diversified career aspirations are within lower risk sectors such as legal,

professional, scientific and technical, the majority are associated with higher risk sectors such as construction, retail, trade, motor vehicle maintenance, and manufacturing (Frey & Osborne, 2017).

In contrast, primary school students expressed more aspirations in the sport, entertainment, and arts sectors (e.g., sportsman/woman, artist), as well as aspirations for other low-risk occupations in the healthcare and education sectors (e.g., teacher, vet, doctor). Excluding aspirations for sportsman/woman (which is currently classified as a Realistic type), fewer primary school students expressed aspirations for careers in the Realistic, Conventional, and Enterprising categories compared with secondary school students. Occupational aspirations in these three Holland Occupational Themes have the highest average probability of automation (Enterprising = 0.27; Realistic = 0.57; Conventional = 0.85). Further descriptive statistics of age differences in automation-related career risks are available in Appendix C, along with accompanying ANOVA results.

3.7.2 Parental occupation differences in automation-related career risks

Corroborating the second hypothesis, primary school students' identification with the occupation of a significant other, particularly a parent, was found to be associated with a greater likelihood of expressing a higher-risk career aspiration. Respondents' disclosure of whether they knew someone who held their expressed career aspiration was found to be a statistically significant independent variable, $p < .001$, $\eta_p^2 = .006$, and power = 1.0 (knew someone: $M = .140$, $SD = .204$, $N = 4006$; did not know someone: $M = .161$, $SD = .175$, $N = 6519$). A slightly larger proportion of respondents expressing medium- or high-risk aspirations compared with those expressing low-risk aspirations indicated on the questionnaire that they knew someone who held a job matching their occupational aspiration (41.88% versus

36.19% respectively). The most pronounced risk disparity within this subset of respondents was having a parent who held an occupation matching their aspiration (47.32% versus 22.62% respectively). In other cases of alignment between respondents' career aspirations and the occupation of a significant other, risk differences were less evident, such as alignment with another member of the respondent's extended family (29.46% versus 33.03% respectively) or a friend (19.05% versus 18.51% respectively).

For those respondents who indicated they did not personally know someone who held a job matching their occupational aspiration, most suggested they heard about their expressed job aspiration through TV/Film/Radio (48.36% versus 46.17% respectively) or personal experiences (42.90% versus 35.51% respectively). Though these results depend on the memory recall capability of the young respondents and may not provide an entirely reliable source of information concerning the influences on children's career aspirations, they indicate how different role models, media, and experiences may influence children's career aspirations (Chambers et al., 2018) and their automation-related risk differences. Among these factors, the influence of parents on school children's career aspirations might be a particularly relevant factor to consider in assessing automation-related career risk differences.

3.7.3 Gender differences in automation-related career risks

Results from the secondary data analysis also supported the third hypothesis. A larger proportion of British male students expressed aspirations for occupations at medium- and high-risk of automation compared to female students (9.19% versus 5.77% respectively). Students' gender was found to be a statistically significant independent variable, $p < .001$, power = 1.0, and $\eta_p^2 = .013$ (boys: $M = .209$, $SD = .192$, $N = 4238$; girls: $M = .104$, $SD = .165$, $N = 4820$). The effect size for gender was

classified as small. On average male students were more likely to express occupational aspirations involving substantial interaction with objects/things (e.g., builder, mechanic, and driver/haulier) and female students were more likely to aspire to people-centred occupations (e.g., hairdresser, nurse, and teacher). Approximately 33% of female students' career aspirations were classified in the Social category (16% for male students). Whereas 48% of male students' career aspirations were classified as Realistic (11% for girls). Occupations containing more manual labour-intensive tasks are thought to be more susceptible to automation (Frey & Osborne, 2017).

Average differences in STEM-related career aspirations were also evident. While proportionally more boys expressed aspirations for to be a scientist and engineer, more girls expressed aspirations for people-centred STEM occupations such as doctor and vet. A larger proportion of female respondents expressed aspirations for higher-status careers such as lawyer and doctor (Chambers et al., 2018). Because many higher-status occupations are estimated to be at low-risk of automation (Frey & Osborne, 2017), current status differences in career aspirations may also contribute to comparatively fewer female students pursuing higher risk careers. However, several lower paying/skilled occupations in the service sector (e.g., waiter/waitress, office admin/receptionist, retail sales assistant), of which proportionally more female students expressed an aspiration for, are also predicted to be at high risk of automation.

3.7.4 Socio-economic differences in automation-related career risks

Results from this data analysis suggest the fourth hypothesis was not conclusively demonstrated. Risk differences between socio-economic groups at the primary school level were not clear enough to be statistically significant, $p = .049$, $\eta_p^2 = .001$,

and power = .645 ($\leq 10\%$ FSM eligibility: $M = .144$, $SD = .169$, $N = 2886$; $> 35\%$ FSM eligibility: $M = .162$, $SD = .204$, $N = 2324$). Approximately 7.73% of students attending schools with a FSM eligibility classification $> 20\%$ expressed aspirations for occupations at medium or high risk of automation. In comparison, slightly fewer students (6.98%) attending schools with a FSM eligibility classification $\leq 20\%$ expressed higher risk career aspirations. Both boys and girls in the lower socio-economic category expressed proportional more occupational aspirations associated with a higher risk of automation than their counterparts in the higher socio-economic group (boys: 9.4% versus 8.44%; girls: 6.07% versus 5.61%).

A reason for the possible risk differences between the socio-economic groups may be due to the larger proportion of students from the lower socio-economic group expressing aspirations for lower skilled or status careers (e.g., mechanic versus engineer, and retail sales assistant versus manager). Many of these occupations are predicted to be more technically susceptible to automation due to the greater number of routine manual and cognitive tasks making up these roles (Frey & Osborne, 2017). However, because the proxy used to estimate respondents' socio-economic background estimated FSM eligibility at the school level rather than individual students, it is possible that an over- or under-estimate in respondents' eligibility for FSM is preventing a clearer statistical picture from emerging.

Primary school students' ethnicity was found to be a statistically significant independent variable, $p = .005$, $\eta_p^2 = .002$, power = 0.92. Across ethnic groups, British Asian and Black respondents were more likely to express career aspirations at low risk of automation than their White and Mixed ethnicity peers. Approximately 8.27% of white students expressed medium or high-risk aspirations, while 5.97% of Asian students and 7.04% of Black students expressed higher risk aspirations. This

finding may be partly explained by the larger proportion of British Asian and Black primary school students expressing higher status aspirations (Chambers et al., 2018) which are potentially less susceptible to automation. The following discussion explores explanations for the identified automation-related risk factors and their significance for children's career pursuits and preparedness.

3.8 Discussion

3.8.1 Automation-related career risks from primary to secondary school

This study set out to identify and explain possible differences in the risks school students may encounter in aspiring to occupations at technical risk of automation.

The first factor considered in this study was the variable of age and how automation-related risks may persist, change, and grow during primary and secondary school.

Results from this analysis showed that after the end of primary education, around the age of 13-14, there is a marked increase in aspirations for occupations associated with a higher risk of automation. Many of these new career aspirations are classified as Conventional and Realistic (e.g., accountant and mechanic). This aspirational change is consistent with previous longitudinal studies (Helwig, 2003).

The aggregate shift in students' career aspirations and associated automation-related risks may be attributed to various psychosocial processes or factors.

Considered through the framework of SCCT, students will accumulate learning experiences about a growing range of occupations (mediated by their personal inputs and environmental affordances) between primary and secondary school.

These learning experiences can produce new or revised career-related self-efficacy beliefs and outcomes expectations, which can in turn reshape or reinforce their career interests and aspirations (Lent & Brown, 2019). Research indicates students' prior achievement experiences in education may play a more prominent role in

shaping their career aspirations than factors such as socio-economic background (Gore et al., 2017). It is difficult, however, to fully account for the marked aggregate change in career aspirations between the short time frame of 11-13 years of age exclusively in terms of incremental changes in SCCT constructs.

Because SCCT does not provide a specific reason or prediction for career-related self-efficacy beliefs and outcome expectations to distinctively change during a given age range, a supplementary developmental explanation may help to elucidate the career pursuit risks children may encounter. Gottfredson (2002) theorises that children around age 14 will orient themselves toward a more internalised, unique conception of self. This process modulates the child's former conception of self as primarily derived from external similarities with others (e.g., sex stereotypes) to embrace a heightened concern for their own distinctive attributes and predilections. The significantly revised or new self-beliefs and personal values children develop at this timepoint may in turn produce a marked modification of their pre-existing career beliefs, expectations, and goals. Using these theoretical insights, it is possible to explain why children's career aspirations undergo a significant diffusion (i.e., less concentrated in specific industries) rather than a considerable broadening (i.e., extended range of career goals) over a short developmental period. A unique self-orientation thus leads some adolescents to construct a more distinctive career identity within their known range of career options.

These identified automation-related career risks raise questions about whether and how career practitioners and educators should take relevant actions to support children's and/or adolescents' career aspirations. While it might be thought that an aggregate shift toward higher-risk career aspirations during adolescence is not of any significant consequence as young people can still change their career

aspirations/choices in early adulthood (and potentially avoid incurring significant opportunity costs), there are several reasons to consider supporting school students to understand and/or navigate the career risks associated with future automation. First, though adolescents can and sometimes do change their career aspirations, at this point in their career development they have already significantly narrowed their career options (Gottfredson, 2002; Helwig, 2001). They have also solidified their career interests to the point where their career aspirations are more stable and predictive of their future career trajectories (Lent, 2013a; Schoon, 2001). The reduced possibility for children in adolescence to adopt new career aspirations or be supported toward certain careers (Archer, DeWitt, & Dillon, 2014), such as careers in lower-risk sectors, could mean that it is increasingly difficult to help young people make informed career choices and adequately prepare for a rapidly changing world of work (Lent, 2013a, 2018).

Insights from this study also indicate that certain groups of school students are more likely to encounter automation-related career risks. It is therefore potentially important for career practitioners and educators to consider how they might support different groups of students in preparing for their future careers. There is evidence to suggest that many young people may lack knowledge and self-beliefs to navigate new changes in the world of work (Speakers for Schools, 2018; WorldSkills & OECD, 2019). Encountering early career barriers or risks associated with job automation, such as unemployment, skill gaps, or misspent financial expenditure (e.g., by choosing certain subjects, qualifications or career pathways affected by automation), can contribute to negative short-term and long-term consequences for young people's careers (e.g., reduced returns) (Möller & Umkehrer, 2015; Mroz & Savage, 2006).

To limit the negative consequences resulting from automation and job change, some have argued that it could be beneficial to support young people in learning about the plausible risks and opportunities associated with automation and changing job markets (Lent, 2018). This should not be done to impose a low-risk career pathway on children. But rather to make them aware of the changing range of occupational options, the increasing role of technology, as well as the evolving skill or task requirements within their preferred sectors (e.g., how they can develop automation-proof skills even in higher-risk sectors) (Lent, 2018). Such learning opportunities may help young people be more responsive to the emerging job opportunities or skill demands created by automation, as well as minimising potential financial, time, and other opportunity costs in pursuing or preparing for certain career pathways. Career learning support for young adolescents or preadolescent children could be particularly beneficial (i.e., before higher-risk career aspirations become more common) and is discussed next.

As children transition into adolescence and orient more towards their unique self (Gottfredson, 2002), practitioners could make use of this developmental mechanism to draw their attention to the new opportunities created by automation and job change and the possibilities these afford for unique self-expression. Engaging children and/or adolescents in learning about job change may also allow them time to build up a range of career-related supports (e.g., career contacts) and strategies (e.g., gaining relevant work experience) to overcome future career barriers (Lent, 2018). Support for children's career self-efficacy beliefs and outcome expectations may also help limit possible self-belief erosion in the event that the changing job market presents a young person with unexpected barriers (Lent & Brown, 2020). In sum, by weighing up the possible advantages and challenges of supporting school

students to navigate or prepare for automation-related career risks, practitioners can develop well-informed decisions about whether, how, and when to aid children in preparing for automation and job change.

3.8.2 Group differences in school students' automation-related career risks

The results from this study indicate various groups of school children may encounter differential automation-related career risks. Beginning with gender differences, a larger proportion of British male school students expressed career aspirations for occupations at medium- and high-risk of automation. Separate research conducted using similar methodologies to this study but with secondary school students, found similar automation-related risk differences between male and female students in the USA and various OECD countries (Hoff et al., 2022; Mann et al., 2020). These gender-based risk differences are in large part attributable to male students' significantly greater proclivity toward manual labour-intensive occupations. Another reason for this risk difference was due to female respondents' greater tendency to aspire to higher status career aspirations. Female students' greater likelihood of expressing higher status aspirations may be significantly related to their presently higher average educational attainment (OECD, 2015; Parker et al., 2018). These two tendencies may contribute to more female school students pursuing occupations less susceptible to automation. This is because of the non-routine and social-intensive tasks making up these occupations (Frey & Osborne, 2017).

While interest and educational attainment differences may result in a higher proportion of female school students aspiring to lower-risk careers, SCCT specifies other factors which may add further complexity to this risk analysis. For example, average gender-based differences in outcome expectations may be a relevant factor. Research has found that when comparing boys and girls of similar educational

attainment, girls are less likely to form career goals based on status or money considerations (Kang et al., 2019). This may provide a counteracting force influencing some proportion of female students to aspire to lower-paying occupations, many of which could be at higher-risk of automation (OECD, 2018). In economies with extremely large service sectors, such as Singapore, females may encounter large career risks as many of these roles could be subject to automation and are frequently female-dominated (Fuei, 2017).

Because of the complex influences and uncertainties in future job automation across different economic sectors, career provisions should be cautious in deterring certain career pursuits to minimise gender differences in automation-related risks.

Nonetheless, there could be an opportunity to engage both male and female students in critical exploration of the psychological and social factors producing differences in career choices as well as preparedness for future automation-related risks and opportunities. Because the task and skill requirements of occupations in male-dominated sectors such as manufacturing and digital fields are changing due to automation (Colombo et al., 2019; World Economic Forum, 2020), such learning opportunities could be beneficial to stimulate young males' development of emerging skills in these sectors, such as social interaction and problem-solving. Equally, young females can benefit from exploring the emerging occupational options and skill/task requirements within different occupations, including the growing need for technological competencies in many fields (Colombo et al., 2019; World Economic Forum, 2020).

There is some evidence from this study to tentatively suggest that students with a parent(s) holding a job with a high susceptibility to automation could be more likely to adopt a higher-risk career aspiration when compared with students with parents

holding low-risk occupations. Through observing and imitating personally identifiable models such as parents, children can learn certain career-related behaviours, beliefs, and may develop corresponding career aspirations (Creed et al., 2007). Parents, as both role models and experienced workers, can help to engage their children in broad discussions about their career, the role of technology in their profession, and the changing world of work more generally. It is important to note the results reported in this study were based on children's self-reports and could therefore be subject to reliability issues, such as children's inaccurate identification of their parents' occupation. However, given the age of the respondents (ages 7-11), there could be good reason to assume that their occupational knowledge or cognitive capacity was sufficiently well developed to accurately identify their parents' occupations.

Unlike gender or age differences, automation-related risk differences across socio-economic groups were not large enough to be statistically significant in this study. Several explanations can be offered to account for these small differences. First, the limitations of the proxy used to estimate respondents' socio-economic background (i.e., FSM eligibility measured at the school level rather than the individual level) may have contributed to an over- or underestimate of the number of respondents from lower socio-economic backgrounds. Additionally, it is possible that the effect size of socio-economic background on primary school students' career aspirations might be small irrespective of age differences (Gore et al., 2017; Howard et al., 2011).

Despite the inconclusive socio-economic results found in this study, a similar multinational data analysis carried out on secondary school students' career expectations found a clearer difference in automation-related career risks across socio-economic groups (Mann et al., 2020). Because children from lower socio-

economic backgrounds are more likely to learn about and observe role models from lower-income or lower-status occupations, they may develop self-beliefs and career aspirations in closer alignment with these types of occupations (Lent et al., 2002). However, a career pursuit risk analysis based narrowly on socio-economic status may leave out other important social factors. Other factors such as ethnicity may also be associated with automation-related career risk differences (e.g., with British Asian and Black students potentially less likely to express higher-risk aspirations). Research with teenagers from lower-income areas of the UK has indicated that adolescents' aspirations are not significantly impacted by labour market constraints and that ethnicity and local circumstances are additionally needed to obtain a richer understanding of young people's career barriers (Kintrea et al., 2015; St. Clair et al., 2013).

Even though some predictions suggest proportionally more low-status or low-paying jobs could be subject to automation (Frey & Osborne, 2017; OECD, 2018), supporting children from lower socio-economic backgrounds will require caution. As some traditionally high-status occupations may also be increasingly subject to automation as well (e.g., accountant and financial adviser) (Frey & Osborne, 2017), career guidance should try to avoid using oversimplified advice to mitigate young people's future career risks. The common adage to simply be more ambitious may not suffice (Hoff et al., 2022). Instead, career stakeholders may support children and young people to understand the nuanced future automation and occupational outlooks (e.g., explaining heuristics about the lower susceptibility of non-routine social and creative tasks). This can include exploring the emerging skillsets and career supports needed to thrive in an occupation or sector irrespective of its future outlook (Lent, 2018).

3.9 Limitations

There were some limitations present in this secondary data analysis. First, as this study did not have access to panel data it was not possible to track the career aspirations of individual students between primary and secondary school.

Nevertheless, the separate survey results used in the data analysis are nonetheless consistent with previous longitudinal research using panel data (Helwig, 2003). Both found an aggregate increase in students' Realistic and Conventional (and potentially higher-risk) career aspirations across primary and secondary education. Second, because the composition of future job markets depends on various uncertain technological, social, and economic factors which remain difficult to precisely predict (i.e., many job automation predictions vary considerably), the results produced in this study using one model of job automation should be viewed as tentative. They are suggestive of a possible career development issue requiring further investigation. Future studies may benefit from more up-to-date and empirically tested models of job automation. Research spanning compulsory and tertiary education may also provide valuable insights on young people's evolving career pursuit risks into adulthood.

3.10 Conclusion

The aim of this study was to investigate differences among school students and various subgroups in aspiring to occupations at technical risk of automation. Results from this study revealed possible risk differences across age, gender, parental occupation, and ethnic groups. A greater proclivity among male students toward thing-centred rather than people-centred occupations may largely explain why a comparatively higher proportion of young males may aspire to occupations at risk of automation. Marked increases in students' higher-risk career aspirations after

primary education (ages 13-14) can be partially attributed to students' expanding learning experiences, beliefs, and knowledge covering a broader range of occupations (particularly more Conventional and Realistic jobs) (Helwig, 2003). This aspirational shift may also be explained by a developmental process occurring around the age of 14 in which young people place a heightened emphasis on their self-uniqueness when forming their aspirations (Gottfredson, 2002).

Though socio-economic differences were not clear enough to be statistically significant, the influence of various social factors, including parental occupation, may mean that some children, by learning from prominent role models and through more exposure to occupations at higher risk of automation (e.g., more routine or low-skilled roles), could encounter greater automation-related career risks over the coming decades. Career practitioners and educators who support children in their career development should be cautious in addressing the differential risks associated with job automation due to the complexity and uncertainty involved in future predictions. Nonetheless, there may be opportunities for practitioners to enhance children's and adolescents' awareness of the changing range of occupational options, the increasing role of technology, as well as the evolving skill or task requirements within their preferred sectors (e.g., whether high- or lower-risk occupations) (Lent, 2018). Practitioners may consider using age-appropriate scaffolding of the content to limit misunderstandings and to support young people to seek out industry experts to verify how technology is reshaping job requirements and workplace environments in different industries.

3.11 Data availability

The datasets obtained and analysed during the current study are available in the “Pupils’ career aspirations and job automation risks” repository,

<https://doi.org/10.7488/ds/2976>.

4.0 Study Two: Review of Career Aspiration Intervention

Approaches

4.1 Chapter overview

This chapter describes the second study in this thesis. Based on the automation-related career risks identified in Study One and possible limitations of commonly used person-occupation matching approaches, there are emerging questions concerning how interventions are supporting children and adolescents to develop their career aspirations under rapidly changing career conditions. To gain insights and identify gaps in recent intervention approaches it was beneficial to examine how recent career aspiration interventions with children (aged 5-18) have/have not addressed job change and the risks associated with automation. To explore this issue a systematic review of literature was carried out. After applying a set of inclusion criteria, 45 intervention studies were selected for the review from a search of over 600 records. Findings indicated that most interventions focused on select demographic groups, sector-specific objectives and learning content (predominantly STEM-related). The intervention objectives and content generally did not address changes within occupations and job markets. Various insights and gaps in recent career aspiration intervention approaches were discussed. The promotion of a meta understanding of job change was also suggested as a supplementary approach. This study was reproduced with permission from Springer Nature.

4.2 Progression from Study One

Results from the first study indicated that different groups of school students, including male students, lower socio-economic groups, and students with parents holding high-risk occupations, could experience new and differential career risks by

aspiring to occupations with a high susceptibility to automation. Some of these risks may include encountering skill gaps, financial loss, or unemployment/job loss in some cases. After identifying a possible issue such as this, a subsequent step to advance an understanding of a problem is to analyse potential approaches relevant to the problem (Osland et al., 2006). Over recent decades, various interventions have been conducted to support children and adolescents in forming their career aspirations (Collins, 1981; Piesch et al., 2020). These interventions have used approaches to target certain occupations/sectors and different groups of young people, as well as providing specific career content and learning experiences to aid young people's career aspiration development.

However, following on from the automation-related career risks identified in Study One, there are potentially new complexities for career aspiration interventions in targeting specific occupations or sectors (i.e., some of which may be partially or entirely susceptible to automation), or supporting select groups of children and adolescents, and providing learning experiences which closely correspond to future occupational and job market demands. Existing intervention approaches which do not address the accelerating changes within occupations and job markets could be inadequately preparing children and adolescents for the emerging career risks associated with automation (e.g., limited job opportunities in specific sectors or new occupational skill and task requirements). On the other hand, supporting young people and particular subgroups with well-planned intervention approaches could aid them in developing career aspirations (and related occupational skills, knowledge, etc.) which are suitably aligned with the availability and requirements of future job opportunities. Such approaches could also help to reduce existing or new career-related inequalities between groups.

Because the approaches used in recent career aspiration interventions can offer important insights and highlight gaps in how children's and adolescents' career aspirations are supported within the context of a rapidly changing world of work, it is beneficial to first evaluate how recent intervention approaches have/have not addressed job change and the risks associated with automation. This can build an understanding of the emerging intervention complexities before trialling entirely new interventions which could have uncertain consequences for children's future career success. For these reasons, this second study set out to critically examine the approaches used in recent career aspiration interventions in relation to the changing conditions underlying careers. By systematically collating and reviewing recent career aspiration intervention studies with children, it was possible to critically evaluate the ways in which the interventions have/have not addressed job change through their objectives and content, along with the evolving career risks and opportunities pertinent to different groups of children.

Knowledge acquired from this review can aid researchers and practitioners in making more informed decisions about the objectives, target groups, and learning content used to support children in forming their career aspirations for a rapidly changing world of work. Towards this end, the next section revisits the importance of children's career aspirations and explains why they have been a focus of career interventions. Thereafter, the potentially emerging complexities of conducting career aspiration interventions with children are discussed.

4.3 The importance of children's career aspirations

Children begin to form aspirations for their future careers from an early age; those as young as five (and plausibly younger) have been observed expressing a career aspiration (Lee, 2012). For the purpose of this study, a career or occupational

aspiration was defined as an “individual’s expressed career-related goal(s)” that refers to attaining a specific occupation(s) or a job in a particular occupational field(s) in the future (Rojewski, 2005, p. 132). Career aspirations are considered distinct from career interests in that the former represents an individual’s career goal(s) given ideal conditions, whereas the latter refers to an individual’s emotional disposition toward certain career options (Nikel, 2021; Rojewski, 2005). A person’s career aspiration or goal may result in specific career-related choices over time (e.g., choosing a certain degree programme or job opportunity) (Lent, 2013b).

Because children’s career aspirations become increasingly realistic and stable as they mature into adolescence (Helwig, 2003), they have been studied for several decades as predictors of later career aspirations and occupational attainment in adulthood (Beal & Crockett, 2010; Schoon, 2001). Schoon (2001) found the career aspirations expressed by British students at age 16 were significantly related to their occupational attainment at age 33, including over 50% of participants aspiring to and then obtaining jobs in healthcare and the natural sciences ($p < .001$). When studying adolescents’ occupational aspirations and occupational expectations together, evidence indicates the former are comparably or more significantly associated with adolescents’ future career-related activities and attainments (Beal & Crockett, 2010; Schoon & Parsons, 2002). Career aspirations may therefore help to predict adolescents’ career pursuits (i.e., their future career-related activities and choices).

Assuming the predictive power of career aspirations there are several reasons to potentially monitor, support, and/or influence young people’s career aspirations. One benefit of doing so may include supporting individuals toward more realistic future job opportunities (i.e., those that are more readily available to attain). Primary and secondary school students’ career aspirations have been previously found to

misalign with current and projected job supplies across many sectors (Hoff et al., 2022; Rogers et al., 2020). Another benefit of career aspiration interventions may include contributing to more socially equitable outcomes by reducing group occupational disparities. For example, reducing STEM attainment disparities between genders or ethnicities. Following these lines of reasoning, various interventions have been carried out over recent decades to influence the career aspirations of children and adolescents (Collins, 1981; Tolbert, 2020). Frequently comprising of career learning activities, self-exploration, and/or other personal development activities, career aspiration interventions may facilitate learning, belief, and interest changes to increase the number of participants expressing a particular career goal(s) (Lent et al., 2002).

Practitioners and researchers have previously conducted these interventions with the intention of more closely aligning young people's career aspirations with available job opportunities and to reduce group occupational disparities, such as increasing the number of females in STEM fields (Archer, DeWitt, & Dillon, 2014; Emembolu et al., 2019). Because career aspiration interventions are designed to influence children toward specific occupations residing in their future, justifications for the intervention aims, participants, and content are to some extent based upon the future makeup of occupations and job markets. However, it is becoming increasingly complex to align intervention approaches with the future career conditions children will experience because of ongoing and accelerating changes across job markets and within occupations (e.g., to task and skill requirements). These changes and implications for career aspiration interventions are discussed in the next section.

4.4 Aligning intervention approaches with changing career conditions

Over the past couple of decades those entering the job market have been more likely to experience non-linear career trajectories and multiple career transitions when compared with previous generations (Chudzikowski, 2012; Sullivan & Al Ariss, 2021). This trend has the potential to reduce the value of career aspiration interventions or person-occupation matching approaches. This is because any initial or desired match between a young person (i.e., their skills, values, and aspirations) and an occupation may fail to occur or continue as the individual experiences job loss or is forced to shift career pathways due to changing job supplies (Lent & Brown, 2020).

Increasing job automation may also add further complexity to supporting young people's career aspirations. While automation of various routine jobs has occurred since the 1980s (Jaimovich & Siu, 2012), recent technological advances in mobile robotics and machine learning are enabling machines to perform a growing range of non-routine manual and cognitive tasks as well as routine tasks (Frey & Osborne, 2017; OECD, 2018). Research by Frey and Osborne (2017) produced a model to determine which existing occupations might be more susceptible to automation from a current technical feasibility standpoint. The researchers suggest occupations and tasks requiring comparatively little social intelligence, creativity, and/or perception and manipulation in unstructured environments are more likely to be subject to automation over the coming decades.

Building on this model, various researchers and organisations have attempted to estimate the potential scale and differential impacts of job automation. Madgavkar et al. (2019), for example, concluded that a larger proportion of male workers may encounter increased occupational attainment difficulties in the next few decades.

This is primarily because they occupy the vast majority of highly automatable manual labour intense jobs and fewer socially intensive roles less susceptible to automation. Similar studies concluded that lower socio-economic groups and young people may especially face greater career pursuit/attainment risks as current entry level, low-paid, and low-skill occupations are increasingly subject to automation (OECD, 2018). Several scholars have nonetheless sought to raise questions about the methodology employed by Frey and Osborne (2017), downplaying the likelihood of mass unemployment, while highlighting the new jobs to be created through gains in productivity and the new occupations branching off newly automated roles (Arntz et al., 2017; Autor, 2015; Shackleton, 2020).

Whilst these critiques highlight uncertainties in predicting the scale and precise consequences of job automation, they do not undermine the general claim that occupations and jobs markets are undergoing significant change with potentially important consequences for children and adolescents. As a result of changes to job markets and to the constituent tasks and skill requirements of occupations, young people's career pursuit risks and opportunities are changing. As demonstrated in Study One, larger automation-related career risks may be encountered by male students, lower socio-economic groups, and students with parents holding occupations which are highly susceptible to automation (Sowa et al., 2022). The range of these risks may include unemployment in some cases, along with financial, psychological, and other opportunity costs resulting from educational and career planning or choice making which is adversely affected by automation (Lent & Brown, 2020). Because these risks and opportunities have rapidly evolved over recent decades, they are raising complexities for career aspiration interventions in targeting specific occupations or sectors, supporting certain groups of children or adolescents,

and providing learning experiences which closely correspond to future occupational and job market demands.

In observing the rise of multiple career transitions and unpredictability in the job market, some scholars have questioned the value of career aspiration/choice making interventions and matching approaches (van Vianen et al., 2009). Alternatives or supplements to career aspiration interventions, such as those developing children's career adaptability resources (e.g., career curiosity and confidence), offer potential benefits in supporting children to better manage career uncertainty and transitions (Ginevra & Nota, 2018). Associated career theories (e.g., career construction) have importantly challenged traditional person-occupation matching approaches by scrutinising the assumption that any pre-identified person-occupation match will likely remain stable or well-fitting due to the enhanced likelihood of a person experiencing multiple career transitions. Instead, some argue that greater importance should be assigned to promoting individuals' capacities to adapt to change and exhibit resiliency (van Vianen et al., 2009).

Possessing the capacities to adapt will likely be important to navigate future career challenges. However, these capacities do not resolve the predicament that young people must process self and occupational information from a shifting range of career options and requirements to make educational and career goals and choices (Lent, 2013a). Because it is not without considerable effort for a person to shift into new occupations or industries (i.e., developing new skills, interests), there may remain value in using interventions to help children develop an early and enhanced understanding of the future job opportunities (Lent, 2018), to prepare for changing occupational skill and task requirements, and/or to limit children's early circumscription of career options (Gottfredson, 2002).

Career aspiration interventions can offer the potential benefit of helping children form more realistic career goals and to reduce disparities in occupational attainments (Piesch et al., 2020). Recognising the value of both perspectives, it was beneficial to draw on a theoretical framework that incorporates a person-occupation alignment approach, along with specifying barriers and supports related to environmental factors such as changing job markets (Lent, 2013a; Lent et al., 2002).

4.5 Theoretical framework

SCCT has been described in previous chapters and will therefore not be explored in detail again here. To briefly summarise, SCCT aims to explain how individuals form career goals and make career choices through the interplay of personal and environmental factors. A child's accumulated learning experiences will influence the subsequent development of their self-efficacy beliefs and outcomes expectations. These will in turn shape their career-related interests and goals (Lent et al., 2002). Perceived and actual barriers and supports from children's background environment and those from environments proximal to choice making (e.g., availability of jobs) are additionally relevant for understanding under which conditions children will form career aspirations and make career choices (Lent & Brown, 2020; Lent et al., 2002). This means the career pursuits and preparedness of children could be modified through learning experiences and by addressing perceived barriers and supports concerning emerging job markets and automation (Hirschi, 2018).

Following the mechanisms set out in SCCT, there are a range of personal and environmental factors that interventions can address to support children's aspirations and preparedness for future careers. Interventions can provide career-related information, identifiable role models, and/or learning opportunities for skill development which closely correspond to the target occupation or sector (Lent et al.,

2002). Coping strategies and environmental supports can be highlighted to prepare children for job change or other environmental barriers (Lent, 2013a; Lent & Brown, 2020). Whilst SCCT provides a useful synthesis of approaches which could be usefully applied to this study, there are some limitations which are worth noting and are elaborated on in the discussion section.

4.6 Research rationale and questions

Career aspiration interventions may serve an important role in supporting young people's career pursuits and addressing persisting issues such as misalignments between aspirations and job markets and group disparities in occupational attainments (Piesch et al., 2020; Rogers et al., 2020). To achieve these goals, intervention approaches may benefit from more closely aligning with changing career conditions. These conditions have become increasingly complex due to job automation and increasing career transitions (Lent & Brown, 2020). Results from Study One highlighted possible automation-related career risks which may impact school children and different subgroups. These risks are potentially diverse and nuanced, affecting some higher status, non-routine occupations as well as routine roles. Due to this emerging complexity, it is important to review how recent interventions have approached the changing career conditions to evaluate a range of possible approaches to the problem. This review could thereby identify relevant insights and gaps in how children's and adolescents' career aspirations are supported for a changing world of work.

Past reviews of career intervention studies involving children have reported some interventions focused on children at the primary school level as well as interventions conducted with adolescents in secondary education (Hughes & Kashefpakdel, 2019; Hughes et al., 2016; Watson & McMahon, 2005). These literature reviews have

explored the impact of interventions on various career constructs, including career exploration, knowledge, attitudes, and adaptability (Hughes et al., 2016; Kashefpakdel et al., 2018; Watson & McMahon, 2005). However, because these reviews have not aggregated and examined interventions targeting children's or adolescents' career aspirations, a strong predictor of young people's future career choices (Schoon, 2001), little is known about how recent intervention approaches are supporting their career pursuits under changing career conditions.

The aim of this study was to critically examine the ways in which recent career aspiration interventions with children and adolescents have/have not addressed the changing conditions underlying careers. By reviewing recent interventions valuable insights and gaps could be identified concerning how young people's career aspirations are being supported for the opportunities and risks of the changing world of work. This was important to investigate as automation and job change may create new unemployment risks and opportunity costs for children and adolescents as future workers and career choice makers (Sowa et al., 2022). To obtain a broad overview of recent intervention approaches across different contexts, including their objectives, target groups, and content, it was determined that a systematic review of published career aspiration intervention studies would allow for an extensive aggregation and analysis of a broad range of intervention approaches. The review addressed the following research questions:

- 1) In what ways are the approaches used in career aspiration intervention studies involving children and adolescents addressing changing career conditions?
- 2) What tensions and gaps exist between career aspiration intervention approaches and the changing career conditions?

4.7 Methods

A systematic review of literature was undertaken to extensively search and collate career aspiration intervention studies across different contexts. This approach helps to minimise biases in the search and appraisal processes as well as the likelihood of overlooking relevant intervention studies using an exhaustive search approach (Grant & Booth, 2009). Alternative methods, such as interviewing researchers and participants involved in recent career aspiration interventions, would be less useful to address the research questions as such approaches would not readily facilitate an aggregation and comparison of a large range of approaches across different contexts. Conversely, a review of published studies can provide easier access to information on an extended range of interventions without encountering difficulties in establishing lines of communication and informed consent with participants (Snyder, 2019).

There are a range of review types with various strengths and limitations (Grant & Booth, 2009). Literature reviews classified as more traditional (e.g., scoping or mapping reviews) offer the benefit of accommodating for time and scope constraints (Rozas & Klein, 2010). However, using these approaches can mean there is a fair likelihood of overlooking relevant studies and including substandard evidence due to the inexhaustive search approach and lack of formal quality assessment (Grant & Booth, 2009; Torgerson et al., 2012). Because an important reason for carrying out this study was to critically examine a range of different intervention approaches to gain relevant insights and identify gaps, it was necessary to search an extensive body of literature to avoid overlooking relevant interventions. This can be best achieved via a systematic review.

Unlike a traditional literature review, systematic reviews involve a rigorous design and use of strategies to limit biases (e.g., reviewer selection bias and publication bias) in the aggregation, appraisal, and synthesis of all studies pertinent to a research topic (Torgerson et al., 2012). They are designed to be explicit, transparent, and replicable so subsequent researchers can scrutinise the reviewers' judgments and try to replicate the findings (Torgerson et al., 2012). While there are various types of systematic reviews, a mixed studies review approach was used in this study. A mixed studies review approach combines qualitative and quantitative studies and uses an exhaustive search approach (Grant & Booth, 2009; Thomas et al., 2017).

Since career aspirations can be measured or described using quantitative measures and/or qualitative descriptions, it was important to include both types of studies to avoid missing relevant career aspiration interventions. This approach also serves to limit some of the problems associated with systematic reviews which are exclusively quantitative, such as being potentially overly reductionistic (i.e., a narrow range of study designs and a limited pool of effect sizes or results) and neglecting the contextual particularities to be found in qualitative studies (MacLure, 2005). To systematically address the research questions, a protocol for the review was produced. The protocol can be viewed in Appendix D. The following sections cover relevant details contained within the protocol, including the methods used to search and select relevant studies, as well as those used to code and synthesise findings from the included studies.

4.7.1 Search strategy

4.7.1.1 Inclusion criteria

The inclusion and exclusion criteria used in this review were informed by the research purpose and questions (Brunton et al., 2017). These criteria refer to different features of the intervention studies, including the study topic, study design, study participants, intervention details, reported outcomes, publication date range, publication language, geographical spread, and explicit descriptions of the study features in the publication (Torgerson et al., 2012). It was important to provide definitions of key terms used in the criteria to give additional clarity to readers and to ensure consistent decisions were made in the search, screening, and data extraction processes (Brunton et al., 2017).

Two important and potentially ambiguous terms used in the inclusion criteria were “career aspirations” and “intervention”. Treating career aspirations as a distinct construct from career interests and expectations, career aspirations were defined as an individual’s expressed career-related goal that refers to attaining a specific occupation or a job in a particular occupational field (Rojewski, 2005). This may typically comprise of participants’ response to a question about the specific occupation(s) or type of occupation(s) they want to hold in the future (e.g., what job do you want to have when you are 30 years old?). The term “intervention” was defined as a planned provision to intentionally influence or support the career aspirations of the intervention participants. The reason for using this definition was to distinguish it from studies reporting an observation (without an intervention) or a natural experiment in which the career aspirations of the participants were reported.

Because the research questions refer to the approaches used in career aspiration interventions involving children (i.e., their design, content, and focus), included studies had to report the intervention objectives, participants’ demographic information, intervention content, methodology, and quantitative and/or qualitative

data on the career aspirations of the participants. Alignments between the intervention objectives, aspiration measurement categories (e.g., STEM versus non-STEM careers), and the intervention content would provide a stronger indication of the intended focus of the intervention (e.g., to influence the adoption of STEM career aspirations). Intervention studies reporting participants' career interests or career expectations and not participants' career aspirations were not included. This decision was made for the reason that career aspirations are more closely associated with career choices/attainments in adulthood (Lent et al., 2002; Schoon, 2001) and they therefore indicate a clearer intent to influence participants' career pursuits or trajectories. Each included intervention study could thus be examined on the basis of being an intentional act to help participants attain certain careers in the future under changing conditions.

Studies in which the participants were not aged between 5-18 years of age (inclusive) were excluded. Five years old was used as the starting age because evidence suggests children can express career aspirations at this age (Care et al., 2007) and it is a common age at which children begin primary school. A cut off age of 18 was used as this is the age of majority in many countries and the age at which many students complete secondary education. Included studies could use any pretest/posttest only design or any pretest-posttest design. The included studies would therefore have to report at least one quantitative or qualitative measure of participants' career aspirations before or after the intervention to indicate the intervention study was indeed concerned with the career aspirations of the participants. Because career aspirations can be described using numbers and/or text both quantitative and qualitative studies were eligible for inclusion.

To be eligible for inclusion the literature must have been published between 1980-2021 (inclusive) in the English language. This time period was selected as significant automation and job change has occurred since the 1980s (Jaimovich & Siu, 2012). Interventions carried out during this period could therefore respond to changing career conditions (e.g., within occupations or job markets). The review was completed in early 2022 and therefore studies published up to the end of 2021 were included. It was necessary for included literature to be published in the English language as this is the primary language of the lead researcher. Included studies could be conducted in any country to enable a review of a broad range of intervention approaches across different contexts. For similar reasons, relevant intervention studies reported in journal articles, reports, conference proceedings, and dissertation/theses were considered eligible for inclusion. The full list of inclusion and exclusion criteria are presented in Table 2.

Table 2 Inclusion and exclusion criteria used in the systematic review

Criterion Type	Inclusion and Exclusion Criteria
Topic	<p>Inclusion: Literature should report an intervention study(ies) designed to influence or support the career aspirations of children.</p> <p>Exclusion: Studies that do not report an intervention designed to influence the career aspirations of children.</p>
Study design	<p>Inclusion: Studies can involve any pre-test only design, post-test only design, an experimental design, or a quasi-experimental design (i.e., with or without randomisation being employed and allocation taking place at either the individual level or cluster level).</p> <p>Exclusion: Studies without a pre-test or post-test measurement of participants' career aspirations.</p>
Participants	<p>Inclusion: Studies where participants are aged between 5-18 years old (inclusive) of any nationality, sex, gender identity, sexual orientation, ethnicity, disability, or learning characteristics.</p> <p>Exclusion: Studies in which the participants are below the age of 5, above the age of 18, and/or are in higher education.</p>

Interventions	<p>Inclusion: Studies reporting on any intervention (online or in-person) designed to influence or support the career aspirations of children.</p> <p>Exclusion: Studies not reporting an intervention designed to influence the career aspirations of children, such as studies exclusively reporting an observation or natural experiment concerning children's career aspirations.</p>
Outcome	<p>Inclusion: Studies reporting quantitative and/or qualitative data on participants' discrete and/or typological career aspirations (at the individual and/or cluster level).</p> <p>Exclusion: Studies not reporting quantitative and/or qualitative data on participants' discrete and/or typological career aspirations (at the individual and/or cluster level).</p>
Recency	<p>Inclusion: The literature must have been published between 1980-2021 (inclusive).</p> <p>Exclusion: Literature published before 1980 or after 2021.</p>
Publication language	<p>Inclusion: The literature must have been published in the English language.</p> <p>Exclusion: Literature not published in the English language.</p>
Geographical spread	<p>Inclusion: The intervention study can be conducted in any country.</p>
Research base	<p>Inclusion: Literature that reports quantitative and/or qualitative data related to the described intervention(s).</p> <p>Exclusion: Literature which does not report quantitative and/or qualitative data related to the described intervention(s).</p>
Transparency	<p>Inclusion: The intervention study objectives, participants, context, content, methodology, and quantitative and/or qualitative data should be made explicit.</p> <p>Exclusion: Literature that does not make explicit the intervention study objectives, participants, context, content, methodology, and quantitative and/or qualitative data.</p>

4.7.1.2 Sources of literature

To locate literature relevant to the research questions, it was important to identify suitable databases and other sources of literature. There are various sources of literature beyond academic databases, including grey literature, hand searching journal contents, checking bibliographies and reference lists. It was important to consider these sources as well due to issues such as time lags between journal

publication and subsequent indexing in a bibliographic database (Brunton et al., 2017).

To achieve an optimal balance of including the maximal number of relevant databases without also selecting an unmanageably large number of sources to search through, a trial search was first carried out. Using the University of Edinburgh library catalogue it was possible to identify various databases/literature collections with significant numbers of results relating to key search terms (key word searches such as “career aspirations” AND “intervention”). To check and possibly expand on this initial list of databases an internet search was undertaken to find and trial similar key word searches in other databases spanning relevant fields such as career development, psychology, education, and sociology. The final list of databases used in the review are presented in Table 3 below.

Table 3 Databases and sources of literature searched in the systematic review

Literature Source	Title
Electronic databases	ERIC Scopus Education database (via ProQuest) British Education Index Australian Education Index Web of Science (Core Collection) APA PsycINFO
Reference lists of past systematic and traditional reviews of career interventions involving children	Watson, M. & McMahon, M. (2005) – Children’s career development: A research review from a learning perspective Prideaux, L.A., Creed, P.A., Muller, J., & Patton, W. (2000) – A review of career interventions from an educational perspective: Have investigations shed any light? Hughes, D., Mann, A., Barnes, S., Baldauf, B., & McKeown, R. (2016) – Careers education: International literature review

	<p>Kashefpakdel, E., Rehill, J., & Hughes, D. (2018) – What works? Career-related learning in primary schools</p> <p>Hidayat, D.R., & Alfian, R. (2020) – Effectiveness of Technology-Based Career Interventions: A Meta-Analysis Review</p> <p>Gardiner, D. & Goedhuys, M. (2020) – Youth aspirations and the future of work: A review of the literature and evidence</p>
Career development journals (searching on journal webpages)	<p>Career Development Quarterly</p> <p>Journal of Career Assessment</p> <p>Journal of Career Development</p> <p>Journal of Counseling Psychology</p> <p>Journal of Vocational Behavior</p>
Google	Google Scholar

These databases and journals were selected on the basis of being some of the most comprehensive sources of career intervention literature across psychology, education, and the social sciences more broadly. They included a mixture of multidisciplinary databases (e.g., Scopus) and discipline-specific databases (i.e., ERIC) within the social sciences. The benefit of these multidisciplinary sources was that they contained many titles with links to key search terms across diverse and relevant areas of the social sciences (e.g., psychology, education, sociology). The education-focused databases spanned different countries (English speaking countries to be consistent with the inclusion criteria) and could thereby help to minimise geographic bias (Torgerson et al., 2012).

Along with these databases and prominent career development journals, Google Scholar was also used to identify any further studies meeting the inclusion criteria. Google Scholar was used as a potential source of literature due to its wide and expansive search potential to uncover titles not found in the more specialised

databases. The reference lists of previous reviews of career intervention literature were also scanned to identify relevant studies. These reviews covered different time frames and various national and international contexts, as well as different age groups (e.g., primary and secondary school students) and different review foci (e.g., technology-focused career interventions). Beyond these sources, contacting study authors via the website Research Gate was done to retrieve articles or material not accessible in other sources.

4.7.1.3 Search terms

For each database a range of search terms including synonyms and international spelling variations, search fields, Boolean operators, and special characters were tested and finalised to achieve a high level of both sensitivity and precision (i.e., retrieving as many relevant records as possible while limiting the total number of records to an appropriately manageable number) (Brunton et al., 2017). For example, certain synonyms of career aspiration (e.g., career goal OR occupational goal) were tested on the ERIC database and eventually disregarded because they did not significantly increase the sensitivity and reduced precision substantially by doubling the number of results to over 500 records.

The search terms related to the research questions and inclusion criteria, covering three distinct categories: career aspirations/goals; children/adolescents/students; and intervention/experiment/programme. With regard to the search term “intervention” and associated synonyms, an additional Boolean (search) operator was used: “NEAR/6 aspiration”. This was important to reduce the number of irrelevant results (e.g., interventions or programmes pertaining to medicine or other non-career fields) by necessitating the search term “intervention” was within six words of the word “aspiration”. Although search terms were largely consistent across

the databases, slight changes were made on different databases to ensure an optimal balance of sensitivity and precision and to work within the functionality of each platform. Table 4 details the list of search terms, Boolean operators, and other fields used in the review.

Table 4 Search terms used in the systematic review

Search terms used on ERIC (access via ProQuest)

Command line search:

YR(1980-2021) AND LA(English) AND TI,AB,SU(career* aspiration* OR occupation* aspiration* OR vocation* aspiration* OR job* aspiration*) AND TI,AB(children OR child* OR adolescent* OR teen* OR youth* OR young people OR pupil* OR student* OR learner* OR boy* OR girl* NOT higher education OR tertiary education OR university student* OR college student* OR graduate* OR undergraduate* OR postgraduate*) AND TI,AB(intervention* OR experiment* OR trial* OR program* NEAR/6 aspiration*)

Key: YR = restrict search by year(s) of publication; LA = restrict search by language of publication; TI,AB,SU = restrict search to title, abstract, or subject; NEAR/6 = finds terms within six words of each other; * = find variations of the search term

Search terms used on Scopus

Advanced search:

PUBYEAR > 1979 AND PUBYEAR < 2022 AND LANGUAGE(English) AND TITLE-ABS-KEY(career* aspiration* OR occupation* aspiration* OR vocation* aspiration* OR job* aspiration*) AND TITLE-ABS(children OR child* OR adolescent* OR teen* OR youth* OR young people OR pupil* OR student* OR learner* OR boy* OR girl* AND NOT higher education AND NOT tertiary education AND NOT university student* AND NOT college student* AND NOT graduate* AND NOT undergraduate* AND NOT postgraduate*) AND TITLE-ABS(intervention* OR experiment* OR trial* OR program*)

Search terms used on Education Database (access via ProQuest)

Command line search:

YR(1980-2021) AND LA(English) AND TI,AB,SU(career* aspiration* OR occupation* aspiration* OR vocation* aspiration* OR job* aspiration*) AND TI,AB(children OR child* OR adolescent* OR teen* OR youth* OR young people OR pupil* OR student* OR learner* OR boy* OR girl* NOT higher education OR tertiary education OR university student* OR college student* OR graduate* OR undergraduate* OR postgraduate*) AND TI,AB(intervention* OR experiment* OR trial* OR program* NEAR/6 aspiration*)

Search terms used on Australian Education Index (access via ProQuest)

Command line search:

YR(1980-2021) AND LA(English) AND TI,AB,SU(career* aspiration* OR occupation* aspiration* OR vocation* aspiration* OR job* aspiration*) AND TI,AB(children OR child* OR adolescent* OR teen* OR youth* OR young people OR pupil* OR student* OR learner* OR boy* OR girl* NOT higher education OR tertiary education OR university student* OR college student* OR graduate* OR undergraduate* OR postgraduate*) AND TI,AB(intervention* OR experiment* OR trial* OR program* NEAR/6 aspiration*)

Search terms used on British Education Index (access via EBSCOhost)

Advanced search (Boolean/Phase):

(career* aspiration* OR occupation* aspiration* OR vocation* aspiration* OR job* aspiration*) AND (children OR child* OR adolescent* OR teen* OR youth* OR young people OR pupil* OR student* OR learner* OR boy* OR girl*) NOT (higher education OR tertiary education OR university student* OR college student* OR graduate* OR undergraduate* OR postgraduate*) AND (intervention* OR experiment* OR trial* OR program*)

Expanders:

Apply related words

Apply equivalent subjects

Limiters:

Publication date: 19800101-20211231

Language: English

Search terms used on Web of Science Core Collection (ordered by newest first)

TOPIC: (career* aspiration* OR occupation* aspiration* OR vocation* aspiration* OR job* aspiration*) AND TOPIC: (children OR child* OR adolescent* OR teen* OR youth* OR young people OR pupil* OR student* OR learner* OR boy* OR girl*) NOT TOPIC: (higher education OR tertiary education OR university student* OR college student* OR graduate* OR undergraduate* OR postgraduate*) AND TOPIC: (intervention* OR experiment* OR trial* OR program* NEAR/6 aspiration*)
Refined by: LANGUAGES: (English)

Timespan: 1980-2021

TOPIC = searches title, abstract and keywords

Sort by Date: newest first

Search terms used on APA PsycINFO

Advanced Search

Any Field: career* aspiration* OR occupation* aspiration* OR vocation* aspiration* OR job* aspiration*

AND

Keywords: children* OR adolescent* OR teen* OR youth* OR young people OR pupil* OR student* OR learner* OR boy* OR girl*

AND

Keywords: intervention* OR experiment* OR trial* OR program*

NOT

Any field: higher education OR tertiary education OR university student* OR college student* OR graduate* OR undergraduate* OR postgraduate*

Date = 1980-2021

Search terms used on Google Scholar

intervention AND children OR adolescent OR student "career aspiration" - university

Date range: 1980-2021

Sorted by relevance

Citations and patents excluded

*Google Scholar automatically searches for synonyms of the key words.

4.7.1.4 Managing and screening search results

To screen and select studies for the review an independent double screening procedure was employed. There was initial title and abstract screening of all records. This was followed by full text screening for those studies showing signs of meeting the inclusion criteria. The lead researcher screened all 671 search results from the identified databases against the inclusion criteria. A separate researcher independently screened a random sample of these studies (33.38% of studies) to minimise individual errors and biases (Kupers et al., 2019). This independent reviewer was a postgraduate student within the same university as the lead researcher, with relevant subject knowledge and research experience in education. To determine the inter-rater reliability, Cohen's k was calculated. Cohen's k was calculated as 0.73 (94.62% agreement). This level of inter-rater reliability is classified as substantial (Kupers et al., 2019). Remaining disagreements regarding which studies met the inclusion criteria were resolved through in-person discussion.

A record keeping log of the search and screening process was produced to ensure transparency and reproducibility. This included the full search history, date of search, source searched, name of the searcher, and reasons for inclusion or exclusion of the document (Brunton et al., 2017). The full search and screening log is available via

the specified data repository at the end of this chapter. Of the 671 studies found from conducting searches on electronic databases (plus 7 more studies identified from reference lists and Google Scholar), 633 studies did not meet the inclusion criteria (including 124 duplicate entries). In total, 45 studies met all the inclusion criteria after full-text screening. Figure 4 depicts the search and screening process undertaken in this review.

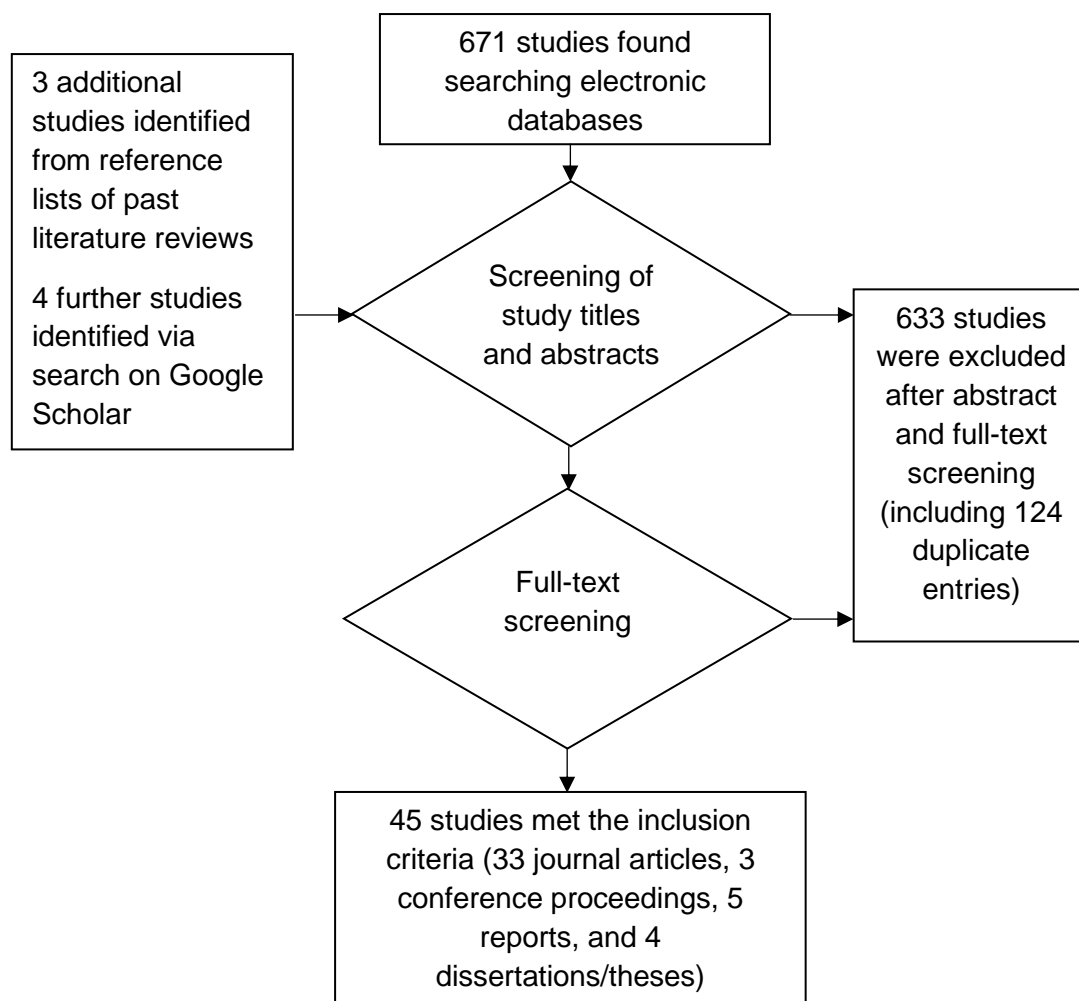


Figure 4 Overview of the search and screening process

4.7.2 Coding and data extraction

To minimise bias coding of the included studies was first carried out independently by the lead researcher. Subsequent comparisons were then made with the codes

separately developed by the second researcher (with minor disagreements resolved through discussion). The coding process involves the systematic application of markers, words, or short phrases to represent and describe key features of studies included in the review (Torgerson et al., 2012). Textual/narrative summaries of the features of each study were made to build up categories covering the intervention approaches and mapping their presence or absence. These features included the intervention topic and objectives, participant information, research design and measurement categories, intervention content, and publication details. As well as coding raw data or first-order constructs (e.g., participant-related data), it was also possible to code and describe second-order constructs (Sutcliffe et al., 2017), such as the study authors' reasoning used to justify the intervention study objectives and content. This served to provide a more comprehensive understanding of the focus and design underling the interventions. Contextual information surrounding the interventions were also recorded to aid this understanding.

To aggregate and compare different features of the interventions (e.g., objective foci, target groups, content types), descriptive statistics were produced and presented graphically in the results section (Sutcliffe et al., 2017). The descriptive statistics and narrative summaries were used to inform an analysis of the insights and gaps in recent intervention approaches designed to influence children's career aspirations under changing career conditions. SCCT and the specified personal and environmental factors influencing career aspirations were used to structure the analysis. Analyses of the intervention approaches were developed in relation to personal factors such as age, gender, socioeconomic background, as well as learning experiences and environmental barriers and supports associated with changing job markets.

4.7.3 Synthesis

A mixed methods approach to synthesis was used in this review. This approach enabled an integration of the narrative summaries with the descriptive statistics to afford a more reliable and in-depth analysis of the intervention approaches.

Comparisons and triangulation across both data types could reduce the potential limitations associated with each methodological approach (Thomas et al., 2017). The quantitative findings were first set out to provide an overview of the intervention approaches used in the studies, including the predominant intervention objectives, measurement categories, and content/activities. As suggested by Thomas et al. (2017), the qualitative data was then examined to substantiate and expand on the general patterns identified in the quantitative results.

Through this synthesis the identified intervention approaches could be critically examined to reveal insights and identify gaps in how recent approaches have addressed the changing career conditions. As well as using SCCT to structure and inform the analysis, results from Study One were also drawn on to examine the ways in which recent intervention approaches are/are not addressing the risks and opportunities associated with automation. After completing the synthesis process, a reflection on the robustness of the review and synthesis approach was carried out. This helped to reveal possible limitations of the decisions made throughout the review (Thomas et al., 2017).

4.8 Results

4.8.1 Publication details of the included studies

Before reporting the aims, target groups, and content of the interventions, publication information is presented to highlight the geographic and temporal breadth of the interventions. Of the 45 career aspiration intervention studies meeting the inclusion

criteria, 32 studies were published between 2010-2021, five studies were published between 2000-2009, six studies between 1990-1999, and two studies between 1980-1989. Studies were mostly conducted in predominantly English-speaking countries, including the United States (22 studies), United Kingdom (7 studies), and Australia (3 studies). This result is likely due to the inclusion criteria requiring studies to be published in the English language. Nevertheless, there are interventions conducted in a range of low-, middle-, and high-income countries (16 different countries). Results are presented in Figure 5 below.

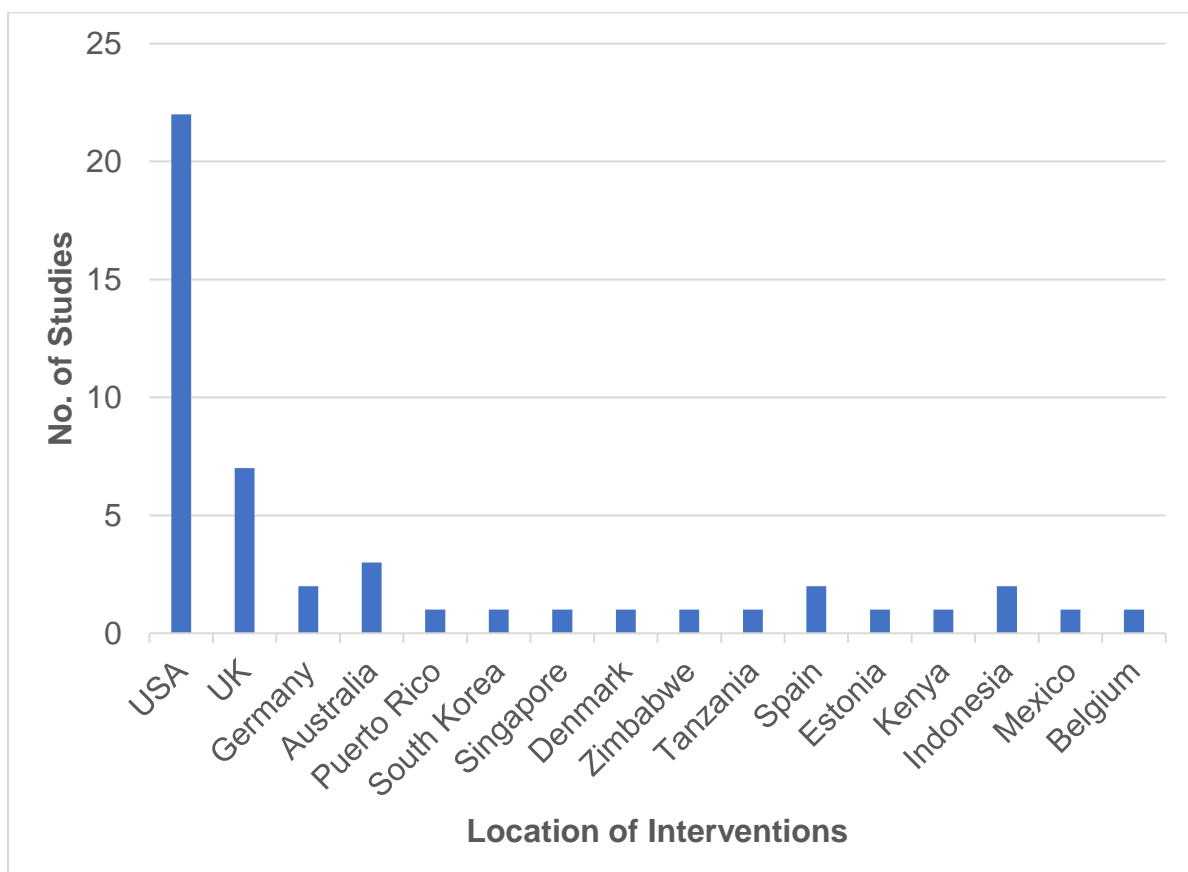


Figure 5 Number of included studies by location of the intervention

4.8.2 Demographic information on the study participants

Most studies (30 out of 45 studies) involved participants primarily between the ages of 11 and 18 years old, including 21 studies involving adolescents between the ages

of 11-15 years old. There were 15 intervention studies involving participants between the ages of 5-11 years old. These demographic results are presented in Table 5 below. Reasons for focusing on specific age groups were largely not articulated in the studies. However, in one study involving students ranging from 13-18 years old (mean age 14.6 years), the researchers emphasised the important subject and career choices young people have to make during adolescence as part of their rationale for the intervention (Piesch et al., 2020). Conversely, in a study involving children aged between 7-11 years old, the authors explained that intervening with this younger age group could be beneficial in supporting children's developing career aspirations in order to reduce persistent group disparities in job aspirations and aspiration-vacancy discrepancies (Emembolu et al., 2019).

Table 5 Demographic information on the participants of the intervention studies

Average age	No. of studies	Gender	No. of studies	Socio-economic group	No. of studies
Age < 6	2	Girls only	9	Lower-income	13
Age >= 6 and < 11	13	Boys only	0	Middle-higher income	4
Age >= 11 and < 15	21	Mixed	36	Lower- & higher-income	7
Age >= 15 and <= 18	9			Unspecified	21

Whilst most studies (36 studies) involved male and female participants, nine studies involved female participants exclusively. Male participants were not exclusively targeted in any of the included studies. The most common rationale for an exclusive focus on female participants, both younger and older age groups, was to address

occupational gender stereotyping and/or to reduce gender-based employment disparities in occupational fields such as STEM (Archer, DeWitt, & Dillon, 2014; Tolbert, 2020).

The socio-economic background of the participants was not reported in 21 studies. However, of the 24 studies reporting the socio-economic status of participants, more studies involved lower-income participants (13 studies) when compared with those involving participants from middle to upper income backgrounds (four studies). Seven studies involved participants from both lower- and higher-income backgrounds. Though most studies did not provide explicit justifications for why they involved participants from certain income groups, some studies involving lower-income participants specified aims to reduce unemployment and to raise the occupational status/earnings among the target population (Collins, 1981).

4.8.3 Career aspiration intervention objectives

To address the first research question and identify the approaches taken in the intervention studies, it was important to consider their stated objectives, measurement categories, and intervention content separately. It was then valuable to examine the alignment between these different elements. This is because the intentions of many of these interventions are not necessarily made explicit or possible discrepancies exist between the objectives, participants, measurement categories, and content. Consistency between these elements within each study may more strongly corroborate conclusions about its intended focus and design to support children's career aspirations.

Additional constructs alongside career aspirations were targeted in the intervention studies, including career knowledge, attitudes, academic achievement, educational

goals, and occupational stereotyping (Bailey & Nihlen, 1990; Park et al., 2009). This section is nonetheless principally concerned with the studies' objectives and accompanying rationale as they refer to influencing participants' career aspirations – a strong predictor of their future career choices (Schoon, 2001). Most studies included in the review do not explicitly provide reasons for why career aspirations were considered important to influence and/or measure. However, in one study the authors explained that “career aspirations are often used as a proxy for students' later career choices” (Piesch et al., 2020, p. 3).

To collate the study objectives as a source of information indicating intervention focus, a classification of the career aspiration objectives was made based on their specificity toward occupational sectors/types. Two broad categories were used to classify the objectives in terms of their specificity toward occupations. Study objectives categorised as sector-specific specified improving, changing, and/or measuring participants' career aspirations with reference to a particular sector or occupation (e.g., computer scientist or STEM fields). Conversely, objectives categorised as sector non-specific specified improving, changing, and/or measuring participants' career aspirations without specific reference to a particular job sector or occupation. Intervention objective results are presented in Figure 6 below.

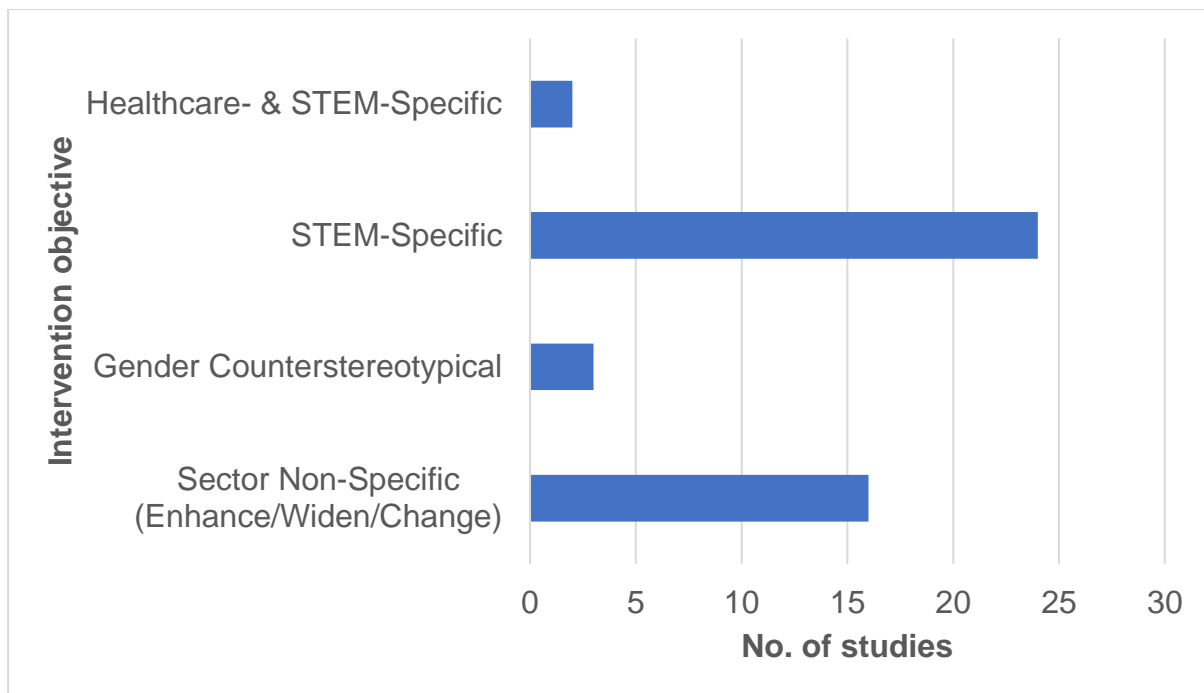


Figure 6 Number of included studies by intervention study objective

4.8.3.1 Interventions with sector non-specific objectives

Around one third of studies (16 out of 45) specified an objective to measure, improve, widen, and/or change the career aspirations of the target population without reference to a particular occupation or sector. Lester (2000), for example, reported a program with the objective to broaden the career goals of indigenous high school students in Australia. After citing empirical evidence regarding the target group's high unemployment and participation in low-paid and insecure employment, the author affirmed "the importance of creating opportunities for [indigenous students to] transition to work in an attempt to reduce future disadvantage" (Lester, 2000, p. 14).

Aside from reference to current employment challenges facing the target group, some studies with sector non-specific objectives described historical changes in the target population's local job market when articulating a case for intervention.

Reaburn et al. (2017) described the lower levels of disposable income and higher

unemployment rates among Tasmanians, as well as the closure of formerly prominent industries such as forestry and manufacturing over past decades. To respond to these changing employment needs and opportunities the intervention “involved targeting school children to assist them to build a broader range of career aspirations” (Reaburn et al., 2017, p. 2). However, despite occasional references to past changes in job markets, future job market changes, such as potential future impacts of technology, were not referred to in the rationale or objectives for these sector non-specific interventions.

Future changes resulting from technology could affect both routine and some non-routine occupations, including certain higher-status roles (Frey & Osborne, 2017). As will be elaborated on in the discussion section, the nuanced impact of automation may mean that contemporary sector non-specific interventions to broaden or raise children’s career aspirations may overlook important future job changes. Rather than simply encouraging young people to aspire to higher-status occupations or consider a broader range of career options, it may be helpful for these kinds of interventions to also support participants’ understanding of how technology can affect different types of occupations and the skills/tasks within occupations. This should not be done to dissuade children and adolescents from high-risk occupations, but to enhance their awareness of the multifaceted changes underway and to build supports to navigate automation-related barriers (Lent, 2018).

4.8.3.2 Interventions with gender-specific objectives

The factor of gender was explicitly referenced in a few intervention objectives. Three studies included in this review stated objectives to influence and/or measure changes in participants’ career aspirations toward gender non-traditional occupations. In one study this entailed exposing primary school children to gender

non-traditional role models and reviewing the impact on their occupational stereotyping and aspirations (Bailey & Nihlen, 1990). Another study examined the impact of an appearance-focused Internet game on young girls' body image and career cognitions and aspirations (Slater et al., 2017). The rationale for these gender counter-stereotypical intervention objectives referred to the need to address children's gender stereotyping of careers and to reduce current gender disparities in occupational attainments such as STEM fields. But these studies did not develop a case for intervening based on the possible future composition of labour markets or evolving skill demands. Results from Study One indicated that young males could encounter new automation-related career risks, as well as some young females in pursuing both gender traditional and non-traditional roles. This raises questions about whether recent gender counter-stereotypical interventions have used an oversimplified approach and neglected important future consequences of automation.

4.8.3.3 Interventions with sector-specific objectives

Intervention studies with objectives to influence and/or measure children's career aspirations toward specific job sectors were commonly found in this review (26 out of 45 studies). These study objectives referred to STEM careers in 24 studies, including one STEM plus arts (STEAM) focused intervention. Two additional studies expressed objectives mentioning both healthcare and STEM careers. While most of these STEM-focused career aspiration interventions involved both male and female participants, specific groups of children were often targeted. Most of these studies involved children in adolescence. There were some female exclusive interventions, as well as many involving lower socio-economic groups, and/or historically underrepresented ethnic groups (e.g., African-American children).

Several justifications for these STEM-focused objectives were expressed, including references to labour market realities, and addressing group attainment differences. Investigating the impact of a technology-enhanced intervention on the IT/STEM learning and career aspirations of US high school students from the Industrial Midwest, Duran et al. (2014, pp. 116-117) described how advances in global IT developments have “decimated the region’s traditional manufacturing–based workforce” and to compete in a global economy students require help to “build skills needed to succeed in a science and technology–driven world”. It was suggested IT/STEM initiatives could open up innovative 21st century career pathways, particularly for African American, Latino, and female students. A similar study examined the contribution of computer-assisted instruction to Korean middle school students’ science achievement, attitudes, and career aspirations (Park et al., 2009). In developing their argument for a sector-specific intervention objective, the authors stated that “without basic numeracy and scientific and technological literacy, students may struggle in today’s labour market and with civic participation” (Park et al., 2009, p. 994).

Unlike studies specifying sector non-specific objectives, some studies with sector-specific objectives occasionally referenced future labour market realities when detailing a rationale for intervention. Emembolu et al. (2019, p. 764) in their study targeting primary school children cited evidence demonstrating the “importance of STEM and the need to increase the numbers and diversity of those choosing these disciplines to meet future workforce demands”. In a six-week STEM careers intervention involving British female students’ (aged 13-14) and a high proportion of ethnic minorities, the researchers indicated that “STEM industries are predicted to grow” in the UK and to a possible “lack of appropriately qualified people to fill key

jobs” (Archer, DeWitt, & Dillon, 2014, pp. 35-36). Additional studies conducted in the US and Spain similarly referred to the growing number of jobs in the STEM sector and the need to meet this demand by reducing gender disparities (Barrett, 2017; González-Pérez et al., 2020; Hur et al., 2017).

Despite occasional references to future job opportunities in STEM, analogous reasoning applied to other sectors, such as healthcare or education, was not evident in the studies’ objectives or supporting rationale. Because these sectors require substantial social intelligence, creativity, and other higher-order skills, they are predicted to be less susceptible to automation and may also be more prominent in the future (Frey & Osborne, 2017; PwC, 2018; World Economic Forum, 2020). While the sector-specific intervention studies more frequently referenced past and future changes in the labour market compared with the sector non-specific interventions, they still could benefit from highlighting certain automation-related changes. For example, even though STEM jobs are predicted to grow, automation-related changes to the tasks within various STEM occupations could make social and digital skills and tasks increasingly prominent (Colombo et al., 2019; World Economic Forum, 2020). It could therefore be important for these changes to be incorporated into the rationale and objectives of these interventions.

4.8.4 Career aspiration measurement categories

To examine the intervention study objectives in a fuller context, findings are presented on the career aspiration measurement categories used in the included studies. Studies with sector non-specific objectives used career aspiration measurement categories such as high and low prestige occupations, professional versus non-professional occupations, aspirations labelled by multiple types or sectors (e.g., arts, science, agriculture), as well as studies reporting participants’

discrete occupational aspirations (e.g., nurse, teacher). For example, using a list of 28 distinct occupations one sector non-specific intervention study recorded the discrete occupations participants expressed as their preferred career when they reach 30 years of age (Schoenfelder et al., 2015).

The most common measurement category used was STEM versus non-STEM occupations (20 out of 45 studies). All the studies using STEM measurement categories also reported STEM-specific intervention objectives. The remaining studies reporting STEM-specific objectives without using STEM binary measurement categories instead recorded the discrete occupations or different sectors preferred by the participants. The three studies reporting gender counter-stereotypical objectives remained consistent by categorising participants' career aspirations using gender traditional/non-traditional measurement categories. A commonality across the different measurement categories used in the intervention studies was reference to pre-existing sets of occupations. There was however no measurement category used to capture aspirations for emerging occupations, such as new jobs branching off recent technological innovations in workplaces (Autor, 2015). The measurement categories used in the studies are shown in Figure 7.

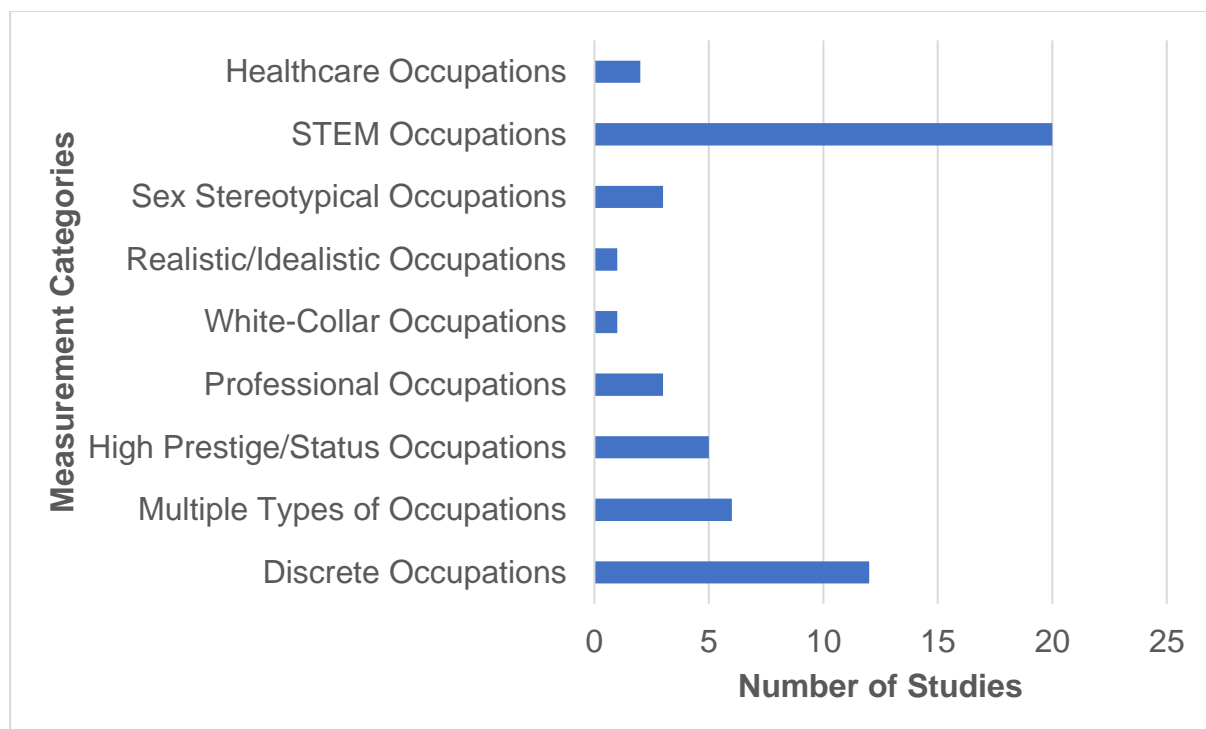


Figure 7 Measurement categories used in the intervention studies

4.8.5 Intervention content

This section reports the content covered in the interventions and the ways in which children's and adolescents' career aspirations were supported. Intervention content from each study was categorised into various content topics and domains based on the content's specificity toward certain sectors, as well as the type of information, knowledge/skills, or practical work experience provided. The sector-specific work experience domain refers to practical experience organised within a workplace setting particular to an occupation or occupations within the same sector (e.g., work in a science laboratory). Content classified as sector-specific skills/knowledge refers to knowledge and skills germane to a particular occupation or sector (e.g., learning about weather topics). The domain entitled information about a specific occupation/sector refers to the provision of information on the characteristics of a particular occupation or job sector (i.e., qualifications, pay, and/or workplace

environment). Whereas the domain named information about multiple occupations refers to information concerning the characteristics of multiple occupations or job sectors.

The multiple career experience domain refers to practical experience organised across several distinct workplace settings. The domain categorised as meta or general career knowledge/skills refers to career knowledge or skills that are not uniquely characteristic of any occupation or sector, but instead involve knowledge or skills associated with the careers domain itself (e.g., career exploration, career management skills, or knowledge about how work connects to other aspects of life). Lastly, the non-career knowledge/skills domain refers to skills not mutually exclusive to careers or to a particular occupation (e.g., communication, critical thinking skills, gender norms and racial discrimination awareness). Most intervention studies provided content from more than one of the seven domains (33 out of 45 studies). Results covering the content domains and topics are presented in Figures 8 and 9 respectively.

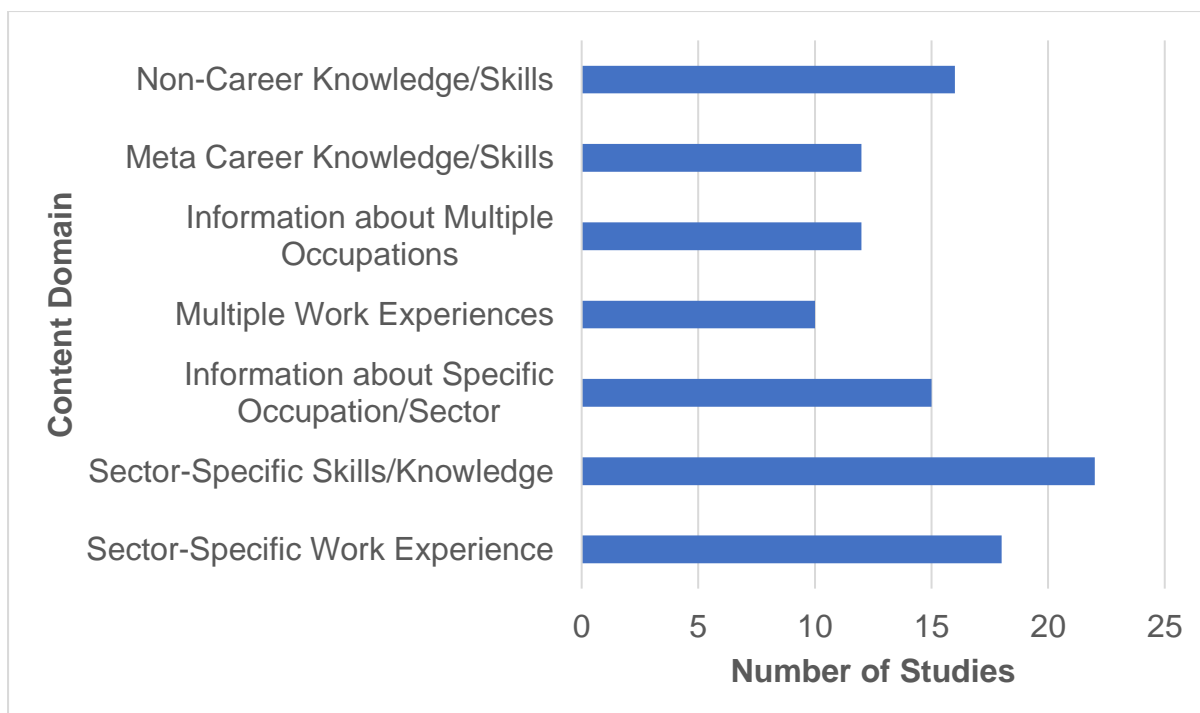


Figure 8 Content domains covered in the intervention studies

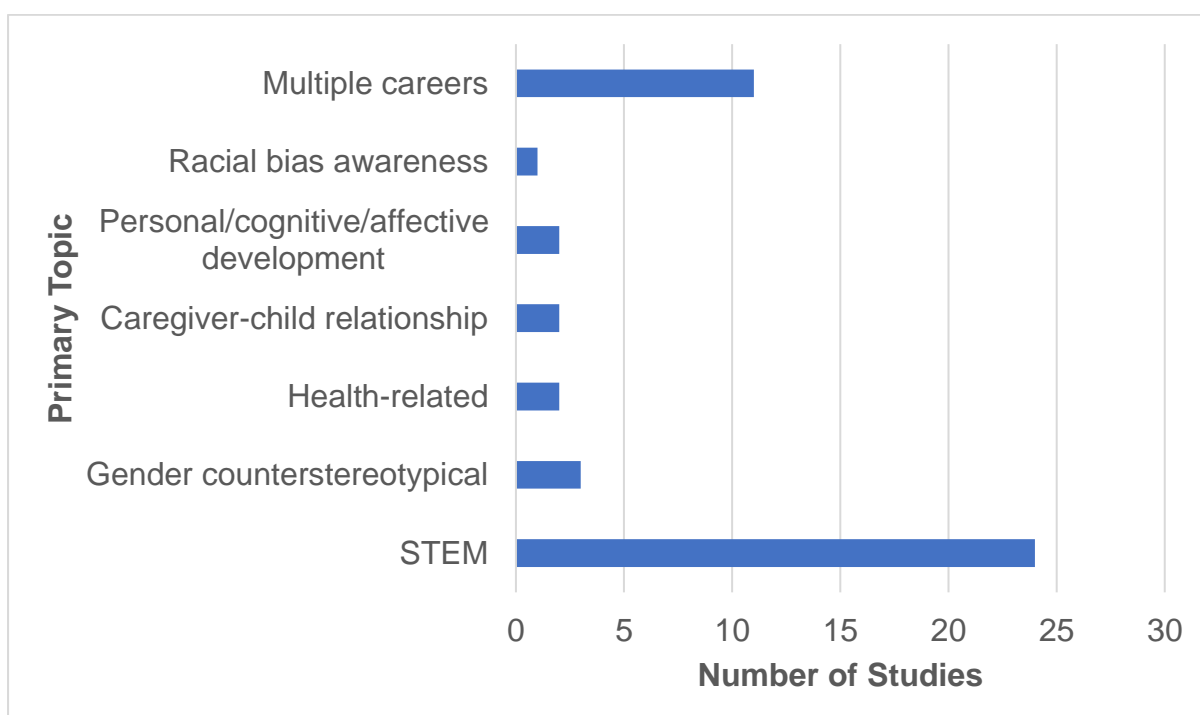


Figure 9 Content topics covered in the intervention studies

The most common content domains used in the intervention studies covered sector-specific skills/knowledge and work experience, with STEM-related topics being the

most common topics (24 out of 45 studies). For example, Emembolu et al. (2019) reported an intervention in which children participated in computer games design activities and used computer software to create their own game. The participants were supported to learn skills and knowledge specific to computer science and games design. After introducing participants to a range of STEM professionals, another intervention reported by Archer, DeWitt and Dillon (2014) encouraged the secondary school students to acquire information about STEM careers by conducting in-depth research into one particular area of interest. This included research on a STEM careers website and creating a presentation about a STEM career.

Consistent with the findings of studies with sector non-specific objectives and measurement categories, interventions with content covering multiple sectors were found less frequently than sector-specific content. Ten studies reported provision of multiple work experiences in the interventions and 12 studies provided information about multiple occupations. Lester (2000), for instance, exposed participants to a broad range of career examples and options outside of the local domain, including exposure to different career role models and multiple workplace visits. In contrast, other studies used non-career knowledge and skill content to influence participants' career aspirations. In one study this included development of caregiver-youth relationships, self-esteem, adaptive control beliefs, and adaptive emotional expression (Schoenfelder et al., 2015). Meta/general career knowledge or skills (e.g., career management skills or knowledge of job markets) were integrated into 12 intervention studies. In one programme this involved learning about the world of work, learning to make career plans and pathway decisions, and learning skills

required to implement career decisions and manage study-to-work transitions (Lester, 2000).

Whilst meta/general career content referring to technology and work was largely absent from the intervention studies, a couple of examples were identified. Barrett (2017) reported an intervention in which participants not only obtained job information in general and information about computer science fields, but also learnt about how technology has and can revolutionise people's lives and positively and negatively impact society. Furthermore, Hur et al. (2017) described an intervention in which several robot demonstrations took place, with supplementary explanations provided on how robots can support human work.

While these few intervention studies offer possible approaches to highlight the potential impact of technology on society and human work, this meta career content did not explore how the availability of different jobs or the tasks and skills of specific occupations could be subject to change over subsequent decades, including the role technology can play in this dynamic process. Exploring the reasons and principles underlying automation and job change (e.g., how routine and some non-routine job tasks could be automated) could benefit young people in understanding what future changes are more or less likely within occupations and job markets. This meta understanding of job change may enable children and adolescents to identify future-relevant career resources and supports, and to form possible backup career plans or barrier-coping strategies to prepare for the emerging risks associated with their primary career choices.

Considered collectively the intervention content, objectives, measurement categories, and target groups provide converging lines of evidence to distinguish a

set of internally consistent intervention approaches. These approaches focused on a relatively narrow range of occupations/sectors, including particular emphasis on supporting children's aspirations for STEM careers. Some interventions focused on promoting aspirations for gender non-traditional professions, as well as support for sector non-specific aspirational changes (e.g., raised occupational status). Female participants and lower-income groups were targeted more frequently, whereas male participants were not exclusively targeted and younger age groups were involved less frequently.

The intervention content most often covered sector-specific skills or knowledge and generally did not cover changes within occupations or those from changing job markets. There was a general approach to addressing careers and the skill and task requirements within occupations as static entities – with limited reference to technological influences or the implications of multiple career transitions. These unaddressed or under addressed areas of recent career aspiration interventions suggest modified or supplementary approaches could strengthen existing interventions to support children's career pursuits for the changing world of work. The next section discusses the insights, potential gaps, and future possibilities for career aspiration intervention approaches as they relate to the personal and environmental factors specified in SCCT.

4.9 Discussion

This study set out to critically evaluate the ways in which career aspiration interventions with children have/have not addressed the changing career conditions. Because children may encounter emerging risks and opportunities in pursuing their future careers due to automation and job change. it was important to review recent intervention approaches to gain insights and identify gaps in how children's career

aspirations are supported. Findings from the review revealed that certain age groups, genders, and socio-economic groups have more frequently been targeted. These personal and background environmental factors are important because they contribute to children's career aspirations and choices (Lent, 2013b). The following part of the discussion sets out to examine these factors and accompanying reasons in the context of automation and job change. Beginning with the identified age-related approaches, a possible need to shift approaches more towards earlier interventions with children to counteract their narrowing of career options is discussed.

4.9.1 Age-related approaches

As indicated in the review findings, comparatively more intervention studies involved children aged between 11-18. There are several reasons why interventions may target children during adolescence. Unlike pre-adolescent children, adolescents are closer to important subject and career decision making points (Piesch et al., 2020) and they likely possess greater career knowledge and understanding of their aspirations to make more informed decisions (Helwig, 2003). Interventions focused on children at this stage of development could therefore affect learning and aspirational change that need only be sustained over a comparably short duration of time to result in career-related choices corresponding to emerging career conditions. This intervention timing may also be consistent with research on how people tend to use availability heuristics when forming a decision by drawing on information that can be more readily recalled from memory (Kahneman, 2011), such as career information acquired close to decision making points (Lent & Brown, 2020).

Emphasising an alternative viewpoint, some intervention studies involving pre-adolescent children followed the reasoning that it is beneficial to support younger

children in forming their career aspirations to overcome persistent group disparities in occupational aspirations and aspiration-vacancy gaps (Emembolu et al., 2019). Children's aspirations become more stable in adolescence, while career stereotyping and narrowing of career options can begin from an early age (Helwig, 2001; Lee, 2012). It is thus plausible that earlier interventions with pre-adolescent children may be necessary to reduce career option narrowing and/or affect sufficient belief and interest change to produce career aspiration changes over the long-term (Archer, DeWitt, & Dillon, 2014). However, findings from this review indicate a possible tension in that most intervention studies involved participants between the ages of 11-18 and often provided learning experiences focused on specific occupations or sectors such as STEM.

Earlier interventions may be increasingly beneficial to help broaden children's career options and/or support their career goals and choices to take advantage of new and shifting career opportunities created by automation and job market change. To address group occupational disparities and aspiration-job market misalignments, dedicated and sustained sector-specific interventions with pre-adolescent children may be necessary to affect sufficient interest and aspirational change. As new jobs emerge and certain types of occupations become increasingly subject to automation, such as various manual labour roles or certain routine cognitive occupations (OECD, 2018; PwC, 2018), sector-specific interventions may become increasingly important to align choice makers with more specialised job supplies (i.e., possible narrowing toward more creative and socially-intensive occupations).

SCCT explains how the development of children's career-specific learning, self-beliefs, and goals can be advanced through the provision of role models, work-realistic learning opportunities, and other sources of information corresponding to the

desired occupation(s) (Lent, 2013a; Lent et al., 2002). To achieve these learning and aspiration development ends, further insights from SCT could be usefully applied. Career interventions can benefit from providing children with models they can closely identify with (e.g., gender representative), as well as using engaging approaches that maintain children's attention, motivation, and retention of the career information (Bandura, 2001; Bandura et al., 2001). However, the optimal type(s) and combination of models or sources of career information most conducive for younger children's career-specific learning and aspirational development is not well understood (Kashefpakdel et al., 2018). Further research into this area could be important to examine the SCCT-informed mechanisms by which pre-adolescent children may be supported in their career aspirations for the changing world of work.

4.9.2 Gender-related approaches

Another personal factor relevant to career aspiration interventions concerns gender. Findings from this review showed most intervention studies included both male and female participants. But in cases where one gender was exclusively focused on, it was solely found to be female participants. Justifications for these female-focused studies most often referenced existing gender-based disparities in STEM occupations and subject choices. Increasing young females' aspirations for STEM occupations remains a plausible intervention approach in many country contexts due to persisting gender-based employment differences in many STEM fields (Archer, DeWitt, & Dillon, 2014) and the low susceptibility of many STEM roles to be automated (Frey & Osborne, 2017).

An overly narrow gender-focused approach to career aspiration interventions may, however, overlook some important emerging career complexities. According to one model of job automation, a lower proportion of socially-intensive occupations and a

large proportion of manual labour-intensive roles are potentially highly susceptible to automation over the coming decades (Frey & Osborne, 2017). As a result of young males greater tendency to aspire to manual labour or thing-centred roles vis-à-vis people-centred occupations (Helwig, 2003), increasing discrepancies between their career aspirations, attainments, and the future job supply may occur over the coming decades (Hoff et al., 2022; Sowa et al., 2022).

For researchers and practitioners to better support boys' and girls' career aspirations for changing career conditions, interventions may go beyond examining traditional gender career stereotyping. It may be beneficial for interventions to also explore how career stereotyping intersects with changing occupations and job market opportunities and barriers. This may include exploring how more low status routine service roles, held more frequently by women, could be affected by automation (Fuei, 2017). Equally, young males could explore how social skills and tasks could become an increasingly prominent part of some male dominated industries (Colombo et al., 2019; World Economic Forum, 2020). Learning coping strategies and developing supports (e.g., career networks) to manage potential job change and to prepare for new occupation-specific skill demands may further benefit male and female children (Lent, 2013a, 2018). Supporting both girls and boys in their career goal setting without oversimplifying job change or imposing lower-risk career pathways could add extra cognitive demands. Nonetheless, such an approach may be important to build children's comprehension of the nuances associated with gendered career preferences.

4.9.3 Socioeconomic-related approaches

In conjunction with personal factors, influences deriving from children's background environment contribute to their career-related learning and aspirations (Lent et al.,

2002). Of the intervention studies reporting the socio-economic background of the participants, a larger proportion involved children or adolescents from primarily lower-income backgrounds. Because of the changing makeup of occupations and job markets, there are supplementary reasons to target lower-income groups to help them attain higher-wage and high-skilled occupations which are potentially less susceptible to automation (OECD, 2018). By providing learning opportunities for occupational skill development and career role models not commonly available in low-income children's socio-economic environment, SCCT suggests new self-efficacy beliefs, outcome expectations, and aspirations toward higher status careers can emerge (Lent & Brown, 2019; Lent et al., 2002).

The task of supporting low-income children toward higher wage or status roles is not without complexity. It is possible some traditionally higher-status occupations could also be increasingly subject to automation over the coming decades (Frey & Osborne, 2017). This information, while absent from the included intervention studies, could be carefully presented to aid lower-income children's and adolescents' career planning for the complex risks and opportunities they may encounter (Lent, 2018). Rather than simply promoting higher-status career aspirations, this approach may include supporting children's exploration and/or acquisition of relevant automation-proof skillsets, qualifications, and supports for their preferred industry. It should be noted however that this more complex approach may carry the risk of causing misunderstandings or provoking anxieties among children. Without due caution or possible mitigation strategies, this could negatively impact children's career aspirations and preparedness.

4.9.4 Career learning approaches

4.9.4.1 Sector-specific approaches

To influence or support children's and adolescents' career aspirations, career content and learning experiences provided through interventions can serve an important role (Lent, 2018; Lent et al., 2002). Review findings revealed most interventions provided learning experiences centred around sector-specific skills and experiences, covering STEM topics most frequently. As a case in point, one intervention set out to develop participants' aspirations for computer science fields by facilitating learning using a storyboard and software to plan and design a computer game (Emembolu et al., 2019). Yet should the constituent tasks of a computer game designer change markedly (e.g., new software or story boarding alternatives), then the skills, self-efficacy beliefs, and outcome expectations participants had acquired to successfully undertake these tasks and achieve in the role could be somewhat negated. Indeed, despite social tasks and interpersonal skills becoming an increasingly prominent part of many technology-based occupations (Colombo et al., 2019), such occupation-specific change was not addressed in the interventions. By conveying a static understanding of an occupation and its constituent tasks, recent intervention approaches may leave children cognitively and emotionally less well equipped to meet emerging demands associated with their preferred career.

Ongoing change within occupations and job markets presents a challenge for recent career aspiration interventions and theories which assume a stable matching between a person's acquired skills and self-beliefs and their subsequent career aspirations and choices. Though Parsons (1909) three-step matching process, which is embedded within SCCT, still offers a useful approach for interventions to facilitate self and occupational exploration and learning, supplementary approaches or learning phases could be beneficial. Approaches which support children to explore rapid changes within occupations and job markets, as well as facilitating coping

strategies or preparedness activities to prepare children for possible career transitions, may ensure person-occupation matches are more aligned and durable (if not always long-lasting) (Lent, 2018; Lent & Brown, 2020). However, due to the uncertainty and complexity of comprehending future job change, these supplementary approaches raise their own challenges. To minimise uncertainty, children could be supported to engage with sector workers to explore technology trends in different industries. This could be done to complement or discredit occupational outlook projections and encourage children to critically examine how occupations are changing and the emerging skills relevant to their career aspirations (Lent, 2018).

4.9.4.2 Sector non-specific approaches

Aside from sector-specific learning approaches, providing a broad range of career learning experiences may offer useful benefits for children's career aspiration formation. Research indicates that learning about multiple occupations and their offerings may have a positive effect on the career aspirations children develop (e.g., higher status aspirations) (Schmitt-Wilson & Welsh, 2012). There could be additional benefits from enhancing children's skills, self-efficacy beliefs, and outcome expectations toward a broader diversity of careers to mitigate the challenges of multiple career transitions. Enlarging children's zone of acceptable alternatives, such as options outside gender or social class stereotypes, may facilitate more efficient transitions into different roles and build their supports (e.g., social networks and material resources) for accessing preferred career pathways (Lent & Brown, 2020). To prepare children for multiple career options it is also important for intervention approaches to facilitate learning on the job creation consequences of new technology. This may help children to expand their field of view beyond presently

existing occupations, developing self-efficacy beliefs and outcome expectations for new careers they could pursue in the future (Hirschi, 2018).

Enhanced awareness of a broader range of careers, including emerging career options, may nonetheless have possible drawbacks. Iyengar and Lepper (2000) reported a series of studies indicating how offering excessive choice options can negatively impact the motivation of the choice maker. As the number of choices in a domain increases, it is argued that the cognitive work required to compare various options can also increase, along with the likelihood of the choice maker perceiving their choice as being suboptimal given the large number of options available. By presenting children with an overly extended range of career options (present and new), it is possible some may experience feelings of regret or uncertainty about the relative quality of their choice or goal (Schwartz & Ward, 2004). Finding an optimal balance in exploring a range of career options and information with children is an important consideration for practitioners. It is also an underexplored line of enquiry to further the development of SCCT as a framework to develop children's self-beliefs and goals for future careers.

4.9.4.3 Meta career understanding

To compliment discrete occupation learning, job market learning or meta/general career knowledge may serve as a useful cognitive resource for children's and adolescents' career aspiration formation. Learning about a sizeable number of discrete occupations and their specific requirements presents a cognitively demanding and time-consuming task for children. Particularly pre-adolescent children who possess comparatively less knowledge of occupations and their requirements (Ferrari et al., 2015). Yet, for the most part the intervention content examined in this review covered occupations and job markets in their current form.

To build on this approach promoting a meta understanding of job change and exploring the implications of technology for job markets could be cognitively beneficial for young people. By learning various principles and heuristics underlying automation and job change (e.g., consider skills that differentiate humans from machines, how routine and some non-routine roles could be automated), children and adolescents could be better equipped to deduce likely changes in occupations and job markets without needing to memorise an extensive list of occupations and their future changes. This understanding can in turn support children's informed career planning and strengthen their beliefs for their career pursuits.

Learning about job change may carry certain risks, such as leading to some career-related anxiety, content oversimplifications, and misunderstandings. However, children's and adolescents' contemporary beliefs and understanding of job change suggests they may already need some support in this area. Several studies examining the factors young people consider when making a career choice suggest that emerging trends in the economy and technology, as well as other factors associated with globalisation, are reported as important to their career deliberations (Mbilini et al., 2019; McDevitt et al., 2013). Recent survey results indicate many adolescents may hold pessimistic views about their future career success within a changing world of work as well as possible misunderstandings about job automation trends (Speakers for Schools, 2018; WorldSkills & OECD, 2019). Given the potential need to promote a meta understanding of job change in interventions supporting children's career aspirations, this area could become a new ground for empirical research. This research may also inform the ongoing development of the mechanisms and intervention strategies proposed in SCCT.

4.10 Limitations

Several limitations of this systematic review are noted. First, the published studies included in this review may only reflect a portion of the total career aspiration interventions carried out globally. This is because the requirement for studies to be published in the English language likely means some quantity of germane intervention studies published in alternative languages have not been included in this review. Excluding intervention studies that reported data on children's career interests (or similar career constructs) without additionally reporting participants' career aspirations also limited the breadth of the review. This decision may however be sufficiently justified on the basis that career aspirations are more closely associated with future career choices and may provide a stronger indication of the researchers' intent to support or influence children's career pursuits in some way.

The descriptive statistics and textual summaries used in collecting and analysing data from the intervention studies may not have entirely captured the full scope of the intervention content or approaches. This may be partly attributable to the word limits imposed on published studies which could restrict the amount of information they report on the interventions. Whilst steps were taken to limit bias in the study screening and coding process (e.g., using an independent reviewer), researcher bias may have potentially impacted the selection and analysis of studies because of inconsistently applied definitions and criteria (Torgerson et al., 2012). Additionally, because inferences made regarding the possible consequences of job automation depend on recent models which remain subject to various socio-economic uncertainties, they should be viewed as tentative and subject to potential revision as new models are developed.

4.11 Conclusion and implications

This systematic review critically evaluated the ways in which recent career aspiration interventions with children and adolescents have/have not addressed the changing career conditions. In so doing several insights and possible gaps in recent intervention approaches were identified. In targeting specific demographic groups, more intervention studies involved children from lower socio-economic backgrounds and some focused exclusively on female participants. A higher proportion of intervention studies also targeted children in adolescence. However, as indicated in Study One, the career risks associated with automation and job change are multifaceted and are potentially spread differentially across groups, including risks for young males (Sowa et al., 2022). Intervention approaches may benefit from addressing the emerging and unique career risks impacting different demographic groups. Because aspirational change is not easily achieved even when self-belief and interest changes occur in adolescence (Archer, DeWitt, & Dillon, 2014), interventions may need to support children earlier in their development to minimise discrepancies between their aspirations and future job supplies or to achieve various social goals.

Most intervention studies in this review included sector-specific objectives and learning content, frequently covering STEM-related topics and skills. This focus generally aligns with predicted future job supplies and automation trends.

Nonetheless, to help children develop skills and beliefs that more closely correspond to future career opportunities such as STEM, intervention approaches could also facilitate learning about the changing task and skill requirements within target occupations or sectors (e.g., emerging social skills in STEM roles) (Colombo et al., 2019). Intervention approaches could expand to include opportunities for observing

role models in emerging industries and obtaining or verifying information on the evolving demands within occupations by seeking out industry insiders (Lent, 2013a, 2018).

Findings from this review revealed recent intervention content has primarily covered the present makeup of occupations and job markets. Promoting children's and adolescents' meta understanding of job change may help young people to comprehend the reasons and principles underlying automation and job change. With this understanding they could better deduce the likely changes to occupations and job markets to inform their career aspirations and planning. Development of relevant supports and barrier-coping strategies to manage job change and uncertainty may offer additional benefits (Lent, 2013a, 2018).

4.12 Data availability

The datasets generated and analysed during the current study are available in the "Systematic Review of Interventions to Influence Children's Career Aspirations" repository, <https://doi.org/10.7488/ds/3454>.

5.0 Study Three: Career Stakeholder & Implementation

Analysis

5.1 Chapter overview

Chapter five details the third study in this thesis. Following on from Study Two and the identified gap of recent intervention approaches generally not addressing job change, it was important to explore the perspectives of stakeholders involved in children's career education to examine how they understand the opportunities and challenges of supporting children's preparedness for automation and job change. To examine stakeholders' perspectives a case study was conducted of the Scottish career education system. This involved a review of career education documents produced by the Scottish Government, interviews with career policymakers, a focus group with career practitioners, and interviews with a sample of primary and secondary schoolteachers. Findings from a thematic analysis revealed that practitioners and policymakers conceptualised automation as creating new occupations rather than resulting in the mass elimination of jobs. Though stakeholders recognised certain job types as more susceptible to automation and differences in the types of occupations various groups tend to pursue, they did not infer that automation may produce differential impacts across groups of children. Along with specifying several practical challenges, stakeholders suggested that learning about the novel developments in technology and job change can serve as a source of curiosity to engage children in their career preparedness.

5.2 Rationale for Study Three

So far, this thesis has set out to estimate the job automation risks associated with children's career aspirations and to examine related insights and gaps in how recent

intervention approaches have supported children's aspirations under changing career conditions. Findings from Study Two revealed that the objectives and content used in career aspiration intervention studies have largely not addressed automation or changes within occupations and job markets. This gap raises the question of whether there is something of significant benefit to be gained from supporting children and adolescents in preparing for their future careers by providing educational opportunities on job change.

Given the possible career pursuit risks identified in Study One, and recent evidence indicating young people's concerns about achieving future career success within rapidly changing job markets (Speakers for Schools, 2018; WorldSkills & OECD, 2019), there may be reason to suppose that without addressing automation and job change some children may not develop the career knowledge and beliefs to form career goals based on a secure understanding of future job realities. However, as suggested in the discussion section of Study Two, career education provisions may nonetheless encounter various conceptual and practical challenges in addressing job change with children and adolescents.

Before moving on to discuss some of these potential complexities, it is worth restating that up to this point this thesis has primarily focused on children's and adolescents' career aspirations. The reason for doing so was because career aspirations are a strong predictor of young people's future career choices (Schoon, 2001) and there is some scope to influence them (Slater et al., 2017). They are therefore an important construct to consider and potentially address due to the rapidly changing career options available to young people. Whilst career aspirations are an important factor in children's career development and future career attainments (Flouri & Panourgia, 2012; Helwig, 2001), there are a range of other

career constructs which can also contribute to their future career success within a changing world of work.

Bringing together some of these constructs (e.g., career adaptability and maturity) under a higher-order umbrella concept, the term *career preparedness* has been developed over recent years to integrate different perspectives on the capacities to identify, manage, and respond to future career changes (Marciniak et al., 2022).

Career preparedness has been defined as the “attitudes, knowledge, competencies, and behaviours necessary to deal with expected and unexpected career transitions and changes” (Marciniak et al., 2022, p. 4).

Supporting children’s career preparedness and pursuits within the context of automation and job change may offer certain advantages. Yet, it may carry with it a range of challenges for different stakeholders as well. One conceptual challenge derives from the present issue that predictions of the future extent of job automation differ significantly (Arntz et al., 2017; Frey & Osborne, 2017; PwC, 2018). Framing career education policy or provisions around one or more of these predictions could positively or negatively impact children’s career preparedness and decision making depending on the accuracy of the projections used (Lent, 2018). Inaccurate conceptions of automation could dissuade some children from careers they may have otherwise achieved success in. Moreover, learning about evolving skills and tasks within occupations could be difficult due to the speed and uncertainty of changes within occupations, such as the increasing prominence of digital skills in manufacturing roles or social tasks in technology jobs (Colombo et al., 2019; World Economic Forum, 2020). Comprehending the rapidly changing nature of technologies (e.g., new AI based technologies such as ChatGPT and DALL-E) and how they are used in workplaces may further add to this complex web of challenges.

Instability in job markets and career pathways presents challenges for career practitioners use of approaches based on person-occupation alignments. This may mean that it is harder to facilitate person-occupation matches which are long lasting (Lent & Brown, 2020). From a practical perspective, engaging children in issues of automation and job change may have the potential to raise anxiety levels by directing their attention to a complex and uncertain future world of work. Recent evidence suggests some young people may hold pessimistic beliefs about attaining careers due to the consequences of automation and changing job markets (WorldSkills & OECD, 2019). Future-oriented career education may also create additional cognitive demands. This could result from the added information processing demands placed on young people to evaluate and choose from a shifting range of career options (present and future) and to comprehend changing occupational and workplace requirements.

Despite the possibility for new conceptual and practical issues to impact career education provisions with children, to date little empirical research has been dedicated to examining the complexities of implementing career provisions to support children in preparing for a changing world of work (Watson & McMahon, 2022). Because these conceptual and practical issues are likely to vary depending on the context and stakeholders involved, it is important to understand the perspectives of different stakeholders who contribute to children's career education. Policymakers, career practitioners, parents, and teachers (as well as peers, media, etc.) can all play a role in shaping children's career development (Taveira et al., 2017). Because different stakeholders can support children in their career education in differing ways, with each holding certain knowledge, values, and institutional priorities, by obtaining, comparing, and integrating their perspectives, it is possible to

acquire a more comprehensive understanding of the contextual career education challenges and opportunities (Ali et al., 2012).

Through exploring stakeholders' conceptions of automation and job change, the associated reasoning behind their policy and programme decision making, and practical approaches to engage children in learning about job change, this research could reveal possible conceptual inconsistencies, as well as practical barriers, trade-offs, and opportunities to enhance children's career preparedness. Use of these findings can contribute to the development of more consistent and comprehensive career policy, along with more effective implementation of career education provisions with children. Toward these ends, the aim of this study was to examine how career policymakers and practitioners perceive automation and job change, as well as the opportunities and challenges they encounter in educating children for the changing world of work.

5.2.1 Study focus

To explore and integrate the perspectives of different career education stakeholders a contemporary case study design was used. This decision was made for certain reasons. Because rapid technological developments (i.e., in AI and robotics) and accelerating occupational change are relatively recent phenomena that will be varyingly experienced and addressed across different country contexts (Arntz et al., 2016; PwC, 2018), a case study offered the opportunity to focus on a specific population or system with greater depth and attention to the context and time period in which the phenomena occur (Yin, 2017). As factors such as differing media coverage and exposure to publications on the subject may contribute to different conceptions of job automation among policymakers and practitioners, it was useful to

use a case study design to contextualise the findings and avoid overgeneralising to dissimilar contexts.

For the purposes of this study, the Scottish career education system was selected as the focus of the case study. Scotland was chosen partly for practical reasons as it afforded easier access for the researcher who is based in the country. But Scotland was also chosen because it is a prominent contemporary example of a country which is making concerted efforts through various career-related policies and provisions to prepare children for the changing world of work (Scottish Government, 2020). The following section explains the structure and different actors making up the career education system in Scotland. An explanation is subsequently provided for why the Scottish career education system offered a valuable case study.

5.3 Scottish career education system

The provision of career information, advice, and guidance (CIAG) in Scotland involves a range of organisations. According to the Scottish Government (2020, p. 12), the “career sector is surprisingly broad with interests in CIAG and work-focused experiences ranging from primary school to post-graduate level, and with career information, advice and guidance, skills assessment and job placement covering the age range from early teens to retirement”. Organisations making up the CIAG system in Scotland are depicted in Figure 10.

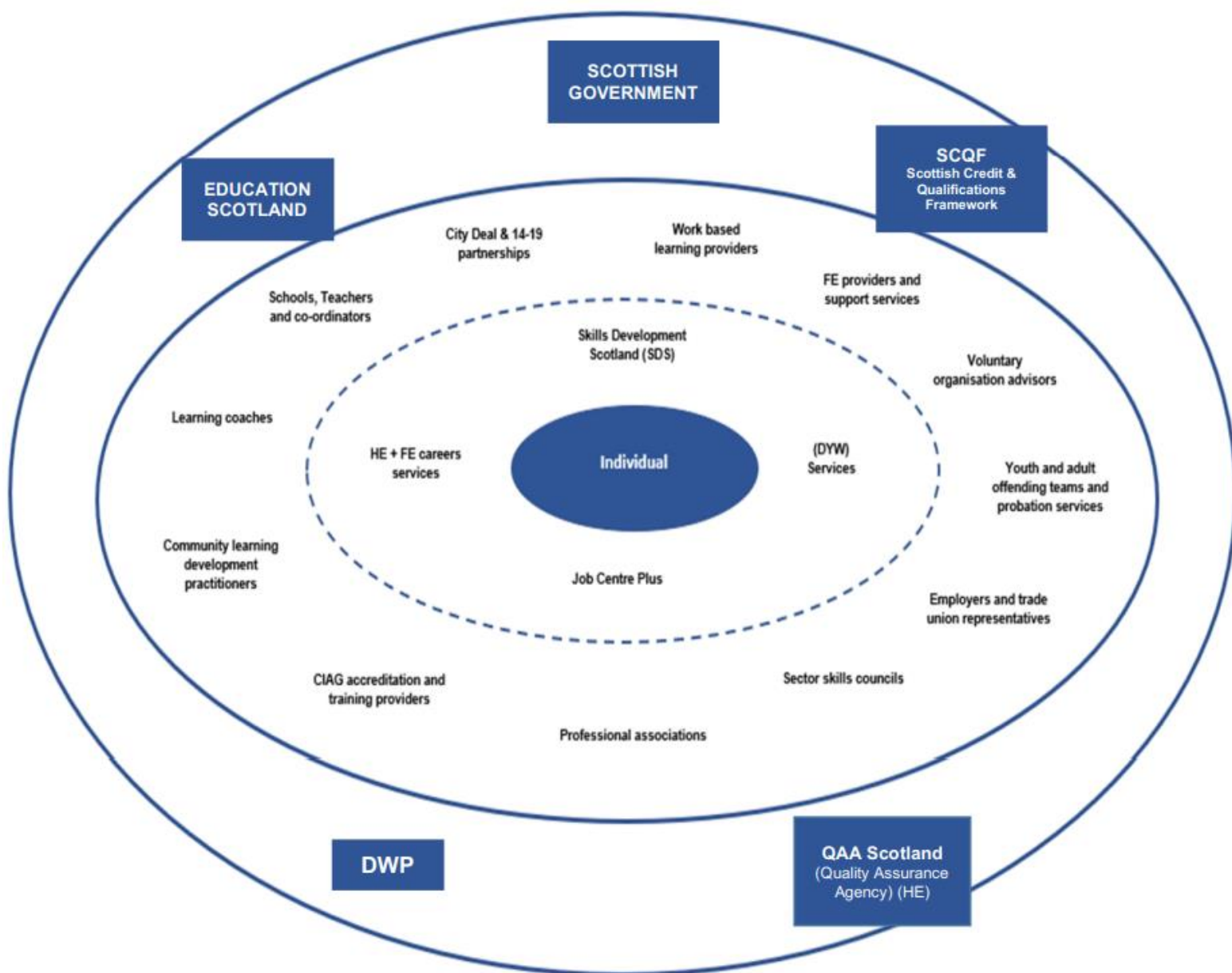


Figure 10 Organisations involved in the provision of CIAG in Scotland
(Scottish Government, 2020, p. 14)

In the outer ring or macro level (i.e., more distal influences affecting children’s career education), organisations such as the Scottish Government and Education Scotland set the policy agenda and standards for CIAG in Scotland. These organisations produce national strategies and policies to inform the provision of CIAG for different

groups in Scotland. In the middle rings or meso level (i.e., more proximal influences), organisations such as schools, colleges, universities, and work-based learning providers facilitate the provision of CIAG for their service users. More specialised career services such as Skills Development Scotland offer technical support on CIAG and work directly with service users, including support for students' career learning in schools (Scottish Government, 2020). According to the Scottish Government (2020, p. 13), a common aim for CIAG organisations is to “assist individuals at differing points throughout their lives to make educational, training and occupational choices and to manage their career within changing education systems and labour markets”.

The provisions offered by these organisations are framed by various national policies and strategies. Some of the most significant national policies and strategies focused on young people include *Developing the Young Workforce: Scotland's Youth Employment Strategy* (Scottish Government, 2014), and the *Career Education Standard* (Education Scotland, 2015a). Following the 2008 global financial crisis, the Scottish Government prioritised and sought to address rising youth unemployment. Following consultations and a report authored by The Commission for Developing Scotland's Young Workforce, the *Developing the Young Workforce: Scotland's Youth Employment Strategy* was produced (Scottish Government, 2014). A key part of the Developing the Young Workforce (DYW) Strategy was to foster partnerships between education institutions and employers, creating opportunities for young people to develop skills, understand and prepare for the world of work. Approximately 21 regional DYW groups were created to help connect schools with employers in their respective locality.

Another recommendation set out in the DYW Strategy referred to the development of a common standard for career guidance and education (Education Scotland, 2015a). Consequently, the publication of the *Career Education Standard* followed in 2015. The document specifies children's (ages 3-18) entitlements and the expectations of parents/carers, teacher/practitioners, Skills Development Scotland, and employers to support children's career learning and preparations for work. The Career Education Standard relates to and builds on the guidance set out in the Scottish school curriculum, the Curriculum for Excellence, as well as the accompanying curricular document *Building the Curriculum 4: Skills for Learning, Skills for Life and Skills for Work* (Education Scotland, 2015a). The Curriculum for Excellence, while not directly referencing automation, emphasises how employment patterns are changing and refers to different industries children need to prepare for. For instance, it is suggested that there is a need to:

help learners prepare for careers in different curricular-related industries, including health and leisure, expressive arts, sciences and technology, social studies, and computing science... Demands and employment patterns are changing, so it is particularly important for all young people to develop high levels of skill and also an understanding of the world of work (Education Scotland, 2004, p. 15).

In conjunction with the Scottish education system, Skill Development Scotland, the national skills development agency, is one of the primary national agencies responsible for providing career education and guidance. Part of the remit of this organisation is to work in and with Scottish primary and secondary schools to provide career education and resources for school students. In some of the documentation produced by Skills Development Scotland automation and the

changing world of work are discussed as an important issue for career development. For instance, in a recent document they discuss the growing role of automation:

Machines will be able to carry out more and more routine tasks, both physical and mental; this leaves, for humans, tasks that are much harder for machines to carry out such as working with and supporting others and using creativity and drive to solve complex societal challenges... Meta-skills and digital intelligence should be developed across the entire education and skills system in Scotland and maintained and further developed in the workplace (Skills Development Scotland, 2018, p. 18).

Recent documents produced by these organisations indicate a growing commitment to help children and adolescents prepare for changes in technology and the world of work. However, while there is some indication that automation and job change are viewed as increasingly important issues for Scottish career provisions to address, it is not clear whether and how this commitment is translating into practice with young people. In this respect the contemporary Scottish career education system offers the possibility of exploring a system-wide case where automation and job change are issues which are potentially being addressed to aid children's career preparedness. Scottish career policymakers, career practitioners, schools, and teachers all have responsibilities toward achieving these goals. Exploring the different perspectives of these stakeholders can reveal the complex set of challenges and opportunities associated with supporting children's career preparedness for a rapidly changing world of work. A study of the Scottish career education system can also unpack the nuances and possible contradictions in how stakeholders conceptualise and practically address automation and job change with children.

5.4 Research goal and questions

Because children can learn about the world of work within and beyond the experience of an isolated career intervention, it is important to examine children's career education within the institutions and contexts in which they live their daily lives (Ali et al., 2012). Governments, schools, career services, and the home environment can all contribute to children's and adolescents' career learning, aspirations, and preparedness (Taveira et al., 2017). Career education provisions within schools and other settings can nonetheless encounter a range of challenges and systemic factors which can impact the implementation of these provisions.

Historically, some of these contextual and practical factors have included time constraints in schools and career services, supporting those from varying social class and ethnic backgrounds, teachers' limited capacity to deliver specialised career content, and establishing or maintaining partnerships with local employers (Ali et al., 2012; Hughes & Kashefpakdel, 2019; Kashefpakdel et al., 2018). Notably, recent research with school leaders indicates a possible lack of understanding of future trends in the labour market (Hughes & Kashefpakdel, 2019; Kashefpakdel et al., 2019). The web of challenges and opportunities career education stakeholders face could be changing in important ways due to rapid developments in digital technologies and the possible implications this may have for the composition of job markets and makeup of occupations. Yet, to-date little research has been conducted to uncover the stakeholder and implementation complexities of educating children for rapidly changing job markets (Watson & McMahon, 2022).

The Scottish career education system offers a prominent contemporary case of a national system which, through various career policies and provisions, is committed to preparing children for the changing world of work. Different stakeholders in the

Scottish career education system, including policymakers, career practitioners, and teachers, have different roles and responsibilities in providing career education for children (Education Scotland, 2015a). Exploring and integrating the perspectives of these stakeholders can help to reveal their conceptions of automation and job change, including possible contradictions or tensions, along with the practical challenges and opportunities they face in addressing the changing career conditions with children and adolescents. This investigation can help to inform career education policy concerning automation and changing job markets, while also revealing practical barriers and possibilities in implementing provisions to support children's preparedness for the changing world of work. Accordingly, two research questions were addressed:

- 1) How do policymakers and practitioners involved in children's career education conceptualise automation and the changing world of work?
- 2) What practical opportunities and challenges do career education stakeholders face in supporting children's preparedness for automation and job change?

5.5 Study design

5.5.1 Case study

Career education stakeholders' conceptions of the changing world of work are temporally and spatially situated, as well as the practical complexities they may encounter (Ali et al., 2012). A study design that allows for a contextually informed investigation of these contemporary phenomena was thus considered important. It was also necessary for the study design to enable the integration of multiple perspectives from different stakeholders and various sources of evidence in order to examine the phenomena from varying standpoints. For these reasons, a case study design was used. The advantage of using a case study design is that it affords an

exploration of a “contemporary phenomenon within its real-life context using multiple sources of evidence” (Robson & McCartan, 2015, p. 150). Compared to other research approaches such as national or cross-national surveys, a case study design offered a more in-depth investigation of stakeholders’ perspectives on addressing automation and job change, along with examining the unique complexities and possible tensions within the Scottish career education system.

The case or focus of a case study can vary depending on the research problem being studied. Common examples of a case include an individual, institution, programme, policy, and/or a system (Ashley, 2021). This case study can be characterised as an embedded case study in that it investigated multiple sub-units of the case (i.e., different institutions, practitioners), along with the case itself (i.e., Scottish career education system) (Yin, 2017). The benefit of this case study design is that it enables the study of the constituent elements of the case, their separate contributions, and how they interact to form the wider phenomenon under investigation (Yin, 2017).

As shown in Figure 10, there are many organisations making up the Scottish career education system. However, to ensure this study was practically feasible (i.e., within the time scope of a doctoral thesis) and to focus on the organisations with a large national presence and an explicit career education remit with children, three institutions were selected for investigation. These institutions included the Scottish Government, Skills Development Scotland, and primary and secondary schools in Scotland. The Scottish Government, including Education Scotland, oversees several national career policies for young people (e.g., Developing the Young Workforce national strategy and the Career Education Standard). Skills Development Scotland produces documents on skill development, careers resources, and delivers career

provisions with children and adults (Scottish Government, 2014; Skills Development Scotland, 2018). Because these institutions have distinct and significant roles in the Scottish careers system (Scottish Government, 2020) and promote conceptions of the changing world of work (Skills Development Scotland, 2018), they were both important sub-units to focus on for the purposes of this case study.

It was also important to explore how primary and secondary schools are supporting children's and adolescents' career preparedness for a changing world of work.

These institutions have been explicitly tasked with this responsibility in the Curriculum for Excellence and Career Education Standard (Education Scotland, 2004, 2015a; Scottish Government, 2009). Schools also work closely with Skills Development Scotland to organise career education sessions for students and often use the career resources provided by Skills Development Scotland in the school curriculum (Skills Development Scotland, 2021a, 2021b). Children spend a significant proportion of their time in schools and can accumulate a large quantity of career learning experiences in this institution (Ali et al., 2012). For these reasons schools were another important sub-unit of the case to examine.

5.5.2 Data collection methods

5.5.2.1 Public documents on children's career education

Conceptions of automation and the changing world of work can be found in a variety of sources. Public documents, whether reports or policy documents, may provide detailed explanations of developments in technology and changes in the world of work. This includes documents published by the above mentioned organisations in Scotland (Skills Development Scotland, 2018). Reports and records produced by governments and organisations not only help to reveal how particular organisations conceptualise problems and propose solutions, but can also contribute to an

understanding of the kinds of assumptions that underlie policy initiatives (Scott, 2000). A review of these documents helped to reveal possible internal contradictions and/or inconsistencies with the institutions' conceptions and practical approaches to addressing automation and job change. It was important to take account of the educational, social, political, and economic context surrounding the included documents to help understand their contemporary meaning (McCulloch, 2012).

To identify and decide which documents to examine in this case Study Two main criteria were used. 1) It was necessary for the documents to be published by the above-mentioned organisations responsible for setting the policy framework and technical guidance for children's and adolescents' career education in Scotland (i.e., the Scottish Government, Education Scotland, and Skills Development Scotland). 2) These documents needed to refer to children's or adolescents' career education and/or preparing young people for job automation and the changing world of work. These criteria were applied to reduce the available pool of career documents to a manageable quantity and to identify documents which were more likely to include conceptions of automation and job change and/or cover conceptual or practical issues related to children's career education in Scotland.

Documents published by other providers of young people's career education (e.g., individual schools, colleges, community groups, and trade unions) were not included in this case study as this would have extended the number of documents beyond what could have been realistically reviewed within the time constraints of the PhD. This decision ensured a focus on prominent documents produced by organisations principally responsible for overseeing and framing career education provisions for Scottish children and adolescents (Scottish Government, 2020). In total, 10

documents were reviewed as part of the case study. These documents are specified in Table 6 below.

Table 6 Career-related documents reviewed in the case study

1) <i>Developing the Young Workforce: Career Education Standard (3-18)</i> (Education Scotland, 2015a)
2) <i>Career Education Standard 3-18: Suite of learning resources</i> (Education Scotland, 2021)
3) <i>Curriculum for Excellence – Building the Curriculum 4: Skills for learning, skills for life and skills for work</i> (Scottish Government, 2009)
4) <i>Curriculum for Excellence: Experiences and Outcomes</i> (Education Scotland, 2004)
5) <i>Skills 4.0: A Skills Model to Drive Scotland's Future</i> (Skills Development Scotland, 2018)
6) <i>My World of Work: Career learning resources</i> (Skills Development Scotland, 2021a)
7) <i>Developing the Young Workforce Work Placements Standard</i> (Education Scotland, 2015c)
8) <i>Developing the Young Workforce School/Employer Partnerships</i> (Education Scotland, 2015b)
9) <i>Developing the Young Workforce: Scotland's Youth Employment Strategy</i> (Scottish Government, 2014)
10) <i>Skills Development Scotland: Career activities and information for school pupils</i> (Skills Development Scotland, 2021b)

5.5.2.2 Sampling and participant recruitment

To combine findings from the document review with the perspectives of key stakeholders, a sample of Scottish career policymakers and practitioners were recruited through email communications with gatekeepers at the Scottish Government and Skills Development Scotland. Two policymakers (one female and one male) from the Scottish Government were recruited based on their involvement in the development and implementation of some of the above-mentioned career education policy documents (i.e., Developing the Young Workforce Strategy and Career Education Standard). These policymakers were purposefully selected so that they could elaborate on the assumptions, aims, and plans underlying the career documents, as well as their understandings of preparing children for automation and job change.

Seven career practitioners/staff members (two males and five females) from Skill Development Scotland were approached based on their role in delivering career education provisions with children and adolescents. The reason for recruiting these practitioners was to explore the insights from Skills Development Scotland staff who regularly work with young people rather than senior staff members who may have little experience of the practical challenges of addressing job change with children. Purposive sampling was used to select these study participants to find relevant cases in the institution who could provide detailed conceptual and practical insights to best address the research questions (Leavy, 2017).

To recruit schoolteachers both convenience and snowball sampling approaches were used. Five schoolteachers (3 primary school teachers and 2 secondary school teachers) working in different schools in the Edinburgh City Council authority area and Scottish Borders Council authority area were recruited. The benefit of using convenience sampling was that it allowed the researcher to recruit participants who

were more readily contactable than would be possible using a probabilistic sampling approach (Leavy, 2017). Though emails were sent out to a larger number of schools in the two Councils, because of the ongoing coronavirus pandemic and additional workloads placed on schools and teachers, recruitment of teachers proved difficult. Consequently, a more pragmatic approach of recruiting teachers using personal contacts and participants themselves was used. The sample of teachers (all females) recruited for the study nonetheless included both primary and secondary school teachers from urban and rural areas of Scotland. By exploring their perspectives, it was possible to examine the conceptual and practical complexities they face in supporting students' career preparedness for the changing world of work.

5.5.2.3 Focus group

To explore the perspectives of career practitioners at Skills Development Scotland a focus group was conducted. Seven staff members involved in the My World of Work Live Programme were invited to participate in the focus group. This programme engages Scottish primary and secondary school students (9-18 years old) in career-related activities (in-person and online), helping children to identify their own interests, skills, and learn about the world of work (including the key sectors and jobs emerging in the Scottish economy). The Programme Manager, five Career Advisers, and one STEM Engagement Adviser working with young people in different regions of Scotland made up the focus group participants. A focus group size of 6-8 participants is generally considered to be more optimal to enable group members to listen and respond to multiple contributions without the conversation extending on for an excessive duration of time (Liamputtong, 2011).

Both programme management and various in-field practitioners were invited to the focus group to provide a wide range of staff perspectives. Because of their unique career advisory experiences, close relationships, and history of working together, a focus group offered the opportunity to bring out the commonalities and distinctions in their conceptions and perceived challenges and opportunities in addressing automation and job change. There is a risk however that focus groups may generate a misleading or false consensus as participants may feel more comfortable agreeing with the contributions of others to avoid perceived social and personal repercussions (Robinson, 2019). To reduce the likelihood of this and the disproportionate input of more dominant or extravert personalities, the lead researcher (acting as the focus group moderator) directed questions both at the group and different individuals to invite a wider range of viewpoints, obtain clarifications, and prompt responses to the different points raised.

The focus group lasted around 50 minutes. Due to social distancing guidelines being in place as a response to the Coronavirus pandemic, the focus group was conducted online using Microsoft Teams. A topic guide with several open-ended questions and prompts were prepared in advance of the focus group (see Appendix E). Questions were crafted with the intention of facilitating open and reciprocal discussion on the topic, with unscripted follow-up questions also posed to the group to pursue relevant lines of enquiry (Robinson, 2019). These questions enquired into the participants' conceptions of the changing world of work, how they approach educating children and different groups for automation and job change, and the practical opportunities and challenges they encounter in supporting children's preparedness for the changing world of work. For example, what is your understanding of how the world of

work is changing? What challenges do you face while supporting children's learning about the changing world of work.

5.5.2.4 Semi-structured interviews

To explore the perspectives of career education policymakers semi-structured interviews were carried out with one staff member working at the Scottish Government, Economic Input and Digital Inclusion team, and another working at the Scottish Government's department for education, Education Scotland. The Scottish Government official was involved in the development and implementation of the Developing the Young Workforce Strategy. Whereas the Education Scotland staff member was involved in the formulation and implementation of the Career Education Standard. Each interview lasted between 30-40 minutes and were carried out on Microsoft Teams. Compared to a focus group or group interview, semi-structured interviews allowed for a more in-depth exploration of each participant's perspectives (Hennink et al., 2020). This was important when collecting data from the policymakers as this enabled more information to be extracted on the career policy documents each policymaker was respectively involved in developing/implementing.

A semi-structured interview format allowed for a pre-planned set of questions to be discussed with each interviewee whilst retaining some flexibility to explore emergent lines of enquiry (Hennink et al., 2020). Interview guides with open-ended questions were prepared for each interview (see an example in Appendix F). Though both interview guides included some similar questions intended to prompt the interviewee to unpack their conceptions and perceived complexities of addressing automation and job change, certain unique questions were posed to each interviewee to explore their interpretation of the respective policy documents they were involved in developing/implementing.

To explore the perspectives of another important group of practitioners formally responsible for providing career education to children, semi-structured interviews were carried out with a sample of Scottish primary and secondary school teachers. Five schoolteachers (3 primary school teachers and 2 secondary school teachers) working in different schools were interviewed individually on Microsoft Teams. Interviews with the schoolteachers lasted around 30 minutes each. Interview guides were developed and included open-ended questions exploring teachers' conceptions of automation and job change, the career learning they support in schools, and the practical challenges and opportunities they face in preparing children for the changing world of work. The semi-structured interview format afforded the opportunity to explore each teacher's personal experiences and perspectives with sufficient rigor and depth, while also enabling emergent issues to be discussed (Hennink et al., 2020).

5.5.3 Data analysis

After collecting data from the public documentation, focus group, and interviews, a thematic analysis was undertaken. A thematic analysis can be used to analyse a range of data sources (e.g., interviews and documents) to capture the expressed thoughts, ideas, and experiences of participants in order to discern repeated patterns of meaning (Braun & Clarke, 2006; Robinson, 2019). Following organisation and description of the data, a process of identifying, interpreting, and reporting patterns or themes in the research data was carried out (Braun & Clarke, 2006). SCCT was used to facilitate the identification, evaluation, and reporting of themes from the data. To identify and examine the complexities of addressing job change with children, SCCT theory was beneficial in explaining relevant personal and environmental factors impacting children's career learning, as well as perceived and actual supports

and barriers related to preparing for changing job markets (Lent & Brown, 2020).

Findings from studies 1 and 2 and recent models of job automation were also used to critically examine stakeholders' conceptions of and approach to addressing automation and job change.

Completion of the thematic analysis involved multiple phases. After reading through and noting preliminary observations of the documents, interviews, and focus group data, initial codes were created by collating and labelling meaningful features of the data across the different datasets (Braun & Clarke, 2006). Data extracts (e.g., quotes from the documents and interview transcripts) were recorded alongside the codes to provide a fuller context. Notes on possible contradictions and recurring patterns were also made. The next phase involved grouping the codes into potential themes; bringing together relevant coded data extracts with the identified themes (Xu & Zammit, 2020). The suitability of the themes was then judged in relation to the entire dataset and the applicability of the associated coded data extracts. Themes were refined to finesse the essence of what each theme means and the overarching story being told (Braun & Clarke, 2006). A thematic map was produced to depict the themes and their relationship to other themes identified in the analysis (Xu & Zammit, 2020).

The full development of the codes and themes can be found in documents stored in the data repository specified at the end of this study. Though steps were taken to minimise the influence of personal biases (e.g., double checking data interpretations with some participants and discussions with other researchers), because this thematic analysis involved some degree of personal interpretation it was important to engage in a process of reflexivity to consider how my beliefs may have affected the research process and findings presented in this chapter (Whitaker & Atkinson, 2019).

Reflections from this process are detailed in the Limitations section toward the end of this chapter.

5.5.4 Ethical issues

Several ethical issues were addressed while completing this case study. Prior to conducting the case study, research approval was obtained from the University of Edinburgh, Moray House School of Education and Sport Ethics Committee, as well as from the Council of the City of Edinburgh. Because the career education documents reviewed in this case study were all within the public domain, there was no legal requirement to obtain permission from the document publishers to access and report on the documents. After sending information sheets to the participants, voluntary informed consent was obtained electronically from each interviewee and focus group participant (see Appendix G and Appendix H for examples of each). Participants were reminded of their right to withdraw from the study and the protection of their anonymity (Byrne, 2023). Due to the ongoing Covid-19 pandemic, a stipulation of the Ethics Committee was for researchers to conduct interviews remotely via Microsoft Teams to ensure the physical safety of study participants. This requirement was duly followed.

In general, the interviews and focus group discussions did not explore or elicit highly sensitive information or responses from the participants. As a result, the risk of causing embarrassment, distress, or reputational damage to the participants was relatively low. Nevertheless, to minimise the risk of causing discomfort it was explained that the discussion was not to be used a part of a performance review or to highlight personal knowledge gaps. But instead involved an open exploration of participants' conceptions of automation and the changing work of work and the practical complexities they face in supporting young people towards their future

careers. When transcribing the interviews and focus group discussions pseudonyms and other concealment measures were used to avoid revealing confidential information or the identities of the participants (Byrne, 2023). To securely store the interview and focus group audio recordings and transcripts, files were saved in a password protected University of Edinburgh OneDrive account. After writing up and anonymising the interview and focus group transcripts, the corresponding audio files were permanently deleted.

5.6 Results

Findings from the case study were organised under five themes. Themes 1-3 relate to the first research question and how Scottish career education policymakers and practitioners conceptualised automation and job change, including possible impacts for different groups of children. Themes 4-5 cover the second research question and the practical opportunities and challenges stakeholders reported in supporting children's preparedness for the changing world of work. The following sections explore each theme in turn and include relevant extracts from the career education documents, focus group, and interviews with policymakers and practitioners. A thematic map is depicted in Figure 11 below to show the key themes and sub-themes from the thematic analysis.

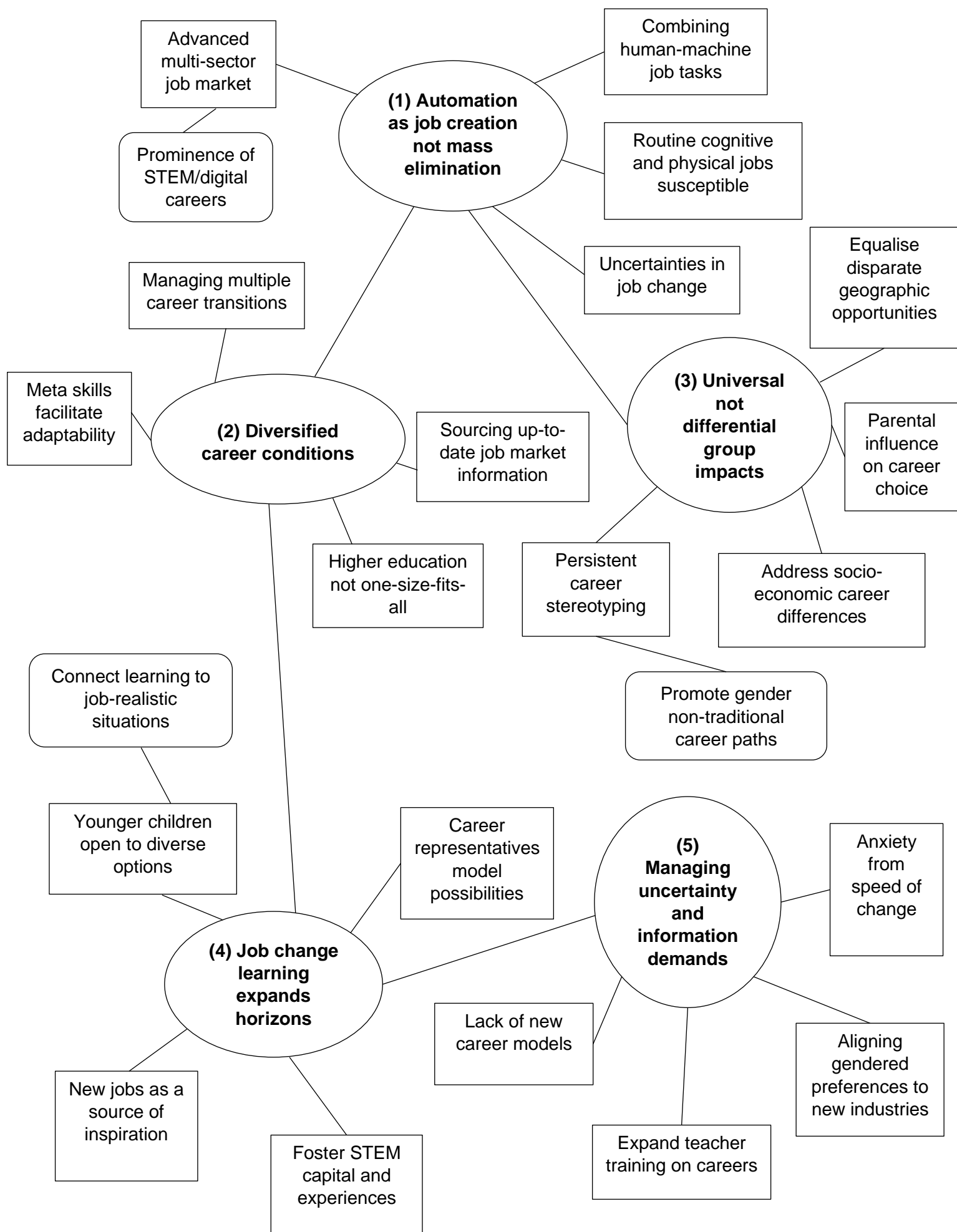


Figure 11 Thematic map of case study findings

5.6.1 Theme 1: Automation as job creation not mass elimination

Across the documentation and interviews with career policymakers and practitioners, automation was widely conceived of as encompassing the creation of new occupations rather than the mass elimination of human-occupied jobs. Career Adviser 1 from Skills Development Scotland explained that: “I think probably 10-20 years down the line we will be in the same position where there will be new roles that we had never thought about.” While the prospect of substantial net job losses was broadly rejected by the career stakeholders, there was frequent acknowledgement that technology has the potential to both replace some present-day occupations and create new jobs. As explained by the DYW Government Official 1:

Because a lot of talk about automation is around how potentially jobs will become redundant and I suppose saying that is somewhat true because we are as a society, we like things quick, and we like things fast pace, and a lot of the times all the quickest ways to do that is through machinery rather than being by hand. But I think we've got lots of new and emerging opportunities for people to work in supporting that.

Automation as dual process of job creation and displacement was recognised to depend on various economic incentives and factors (e.g., consumer demands for cheap and efficiently produced products). However, despite the largely optimistic framing of automation, uncertainty in predicting future job change was reiterated in published career documents, as well as by the career policymakers and practitioners. In documentation produced by Skills Development Scotland on preparing children and adults for Industry 4.0, it is explained that “although we can

anticipate a number of key trends and their impact on the way we work and live, the only thing we can be certain about for the future is uncertainty itself” (Skills Development Scotland, 2018, p. 6). Schoolteachers who participated in interviews also expressed concern about the complexity of preparing children for the future given the uncertainty in the world of work. Primary school teacher 1 explained:

So, I'm preparing them a little bit for the unknown. But I do find it quite challenging because I don't know what the future holds for them and what to prioritise in their learning.

While acknowledging the uncertainty associated with predicting changes in the world of work, policymakers and practitioners were nonetheless willing to reference certain sectors and types of occupations as more likely to be increasingly prominent in the future. The Programme Manager from Skills Development Scotland outlined some of these more prominent sectors: “digital and IT, advanced manufacturing, finance, early years and childcare, health and social care, life and chemical sciences, construction, and engineering”. These highlighted sectors are consistent with those detailed in documentation produced by Skills Development Scotland (Skills Development Scotland, 2018), as well as many sectors mentioned in Curriculum for Excellence documents (Education Scotland, 2004).

Frequent reference was made to the future growth of digital fields, with the DYW Government Official 1 suggesting: “I suppose a lot of it's probably just around the kind of wider digital fields... It's a big thing for kids nowadays and I think that's probably an industry that's quite booming”. There was also a common view held by most interviewees that high-skilled occupations will be less susceptible to automation primarily due to the complexity and non-routine tasks contained within these

occupations. The automation of routine manual labour and cognitive work was conceived of as more likely than non-routine work.

Though stakeholders' conceptions of automation referred to broad differences between routine and non-routine occupations, several documents and stakeholders added further nuance by also specifying that non-routine tasks in certain occupations could also be susceptible to automation. As secondary school teacher 1 commented: "I think that there's probably different kind of levels and complexities to the different types of automation; because I mean even hard parts of like lawyers' jobs and things like that, you know, could potentially be automated as well as kind of mechanical processes." The combination of human- and machine-controlled tasks within many occupations was raised as a likely consequence of future job change. This was exemplified in the following way by Education Scotland Official 1: "as a technician in a workshop or as a car mechanic you will have less oil on your fingers and more like working out laptop diagnostics." These separate conceptions articulated by stakeholders, while not inconsistent, connote more nuanced and cautious messages of job change uncertainty and complexity when juxtaposed with a positive framing of the job creation consequences of automation. The challenge of interpreting these contrasting messages could raise difficulties for children's career preparedness.

5.6.2 Theme 2: Diversified career conditions

Reflecting on future changes in the world of work, career policymakers and practitioners raised conceptions which indicated a diversification of career conditions. While the emergence of new jobs and industries would offer new opportunities for young people, the possibility of a young person remaining in a single career was perceived as increasingly less likely. Career Adviser 1 explained this idea by suggesting that young people: "they'll have different jobs, and the transferable

skills are kind of essential to... helping you go for different jobs in different sectors”.

Secondary school teacher 2 further elaborated on this:

now people tend to talk a lot more about sort of portfolio careers. So, various jobs that you know you might dip into and then move on to something else. I think a huge amount of that has obviously got to do with technology.

To prepare children for new job opportunities and non-linear career trajectories, many of the interviewees and career documents placed importance on supporting children’s learning of widely applicable work skills or so-called meta-skills. The Skills Development Scotland Programme Manager explained: “we are very focused on making sure that we talk about meta skills so that young people understand that those skills are the skills that all employers are going to be looking for.”

Documentation produced by Skills Development Scotland outlines these meta skills, including self-management (focusing, integrity, adapting, initiative), social intelligence (communicating, feeling, collaborating, leading), and innovation (curiosity, creativity, sense making, critical thinking) (Skills Development Scotland, 2018). In addition, career management skills were highlighted in Scottish career documents and by several interviewees as competencies needed to navigate the changing career conditions. Supplementary documentation to the Curriculum for Excellence explains that:

Career management skills should be set within the establishment’s wider approach to learning, skills development, and personal development. It encompasses the skills, knowledge and self-awareness to develop aspirational career aims and the confidence to take actions in one’s life, time

and again, as career opportunities arise and as work and learning options change (Scottish Government, 2009, p. 13).

While stressing meta skills and career management skills as essential resources for young people's adaptability to job change, career stakeholders nonetheless implicitly maintained an assumption that person-occupation alignments could also be facilitated through the provision of job/industry-specific information. As explained by the Programme Manager at Skills Development Scotland: "we use labour market information to kind of back all this up... [we] give the young people information around that." Career Adviser 4 explained that: "if we can see that there's going to be a 20% increase in a certain job or something in the future, it's more encouraging... for young people to be part of these different situations." In addressing job change, career adaptability was thus treated as a necessary but not a sufficient condition. A person-occupation matching process, particularly for emerging sectors such as STEM, supplemented stakeholders' repertoire of approaches to prepare children for the changing world of work.

5.6.3 Theme 3: Universal not differential impact across groups

Several tensions and possible contradictions were evident as interviewees discussed the possible impact of automation on different groups of children. When presented with a question about whether automation and job change may contribute to differential impacts across groups, interviewees broadly took the view that all children will be impacted by automation irrespective of their group membership. Career Adviser 3 stated that: "I think everybody like is gonna be affected by the changing world of work." Secondary school teacher 2 explained: "I think the challenge would be similar... equally the amount of support to deal with changes." Primary school teacher 1 shared this perspective and made a case for presenting

career options to all children without specific consideration to their group

characteristics: “I think you try and give lots of options all the time and you're not being specific about who those options are for.”

Stakeholders' views about the generally undifferentiated impact of automation across groups may, however, produce a possible inconsistency when combined with their understanding that automation could impact certain types of work more than others (e.g., low-skill and manual labour jobs) and that different groups of children tend to hold differing career aspirations. Education Scotland Official 1 acknowledged that “there are people who have dispositions [toward certain careers]”. Career Adviser 1 suggested that there is a “bias in choosing roles and how people choose roles and gender stereotypes in picking roles.” The STEM Engagement Adviser from Skills Development Scotland provided a developmental observation to illustrate the emergence of career stereotyping:

between the nursery and primary one transition something happens that all of a sudden boys can be mermaids [and] girls can be digger drivers in nursery; and then they go to primary one and girls can't wear blue.

Socio-economic group differences in career aspirations and attainments were also noted by interviewees. The DYW Government Official 1 explained: “if you're in a SIMD 20 (from one of the most deprived areas according to Scottish Index of Multiple Deprivations) you get potentially lesser education and potentially you're in a household where potentially people don't work.” Yet despite these observations about low-income groups and gender differences in career pursuits, the career documentation and stakeholders did not infer a logical connection between group aspirational differences and the possibly of differential career risks across groups as

a result of the automation of different job types. This could be an important oversight as the results from Study One indicated that there may be significant automation-related career risk differences across gender, social-economic class, and other group categories. Inadequate recognition of these group differences in Scottish career policy and among practitioners could lead to problems for those groups who may benefit from new or revised forms of support.

This oversight notwithstanding, addressing career stereotyping and promoting non-traditional pathways was considered important by many interviewees. In documents accompanying the Career Education Standard, stakeholders are encouraged to identify and accommodate children from disadvantaged groups and help them in overcoming the barriers they may face in realising their educational and career aspirations (Education Scotland, 2021). The Programme Manager for Skills Development Scotland further elaborated by suggesting they aim to promote: “girls in science roles and you know young males in health and social care roles”, as well as taking “kit into schools to try and offset that digital poverty aspect.” Providing lower-income school children with enhanced access to digital technologies and learning experiences was considered important on the grounds that they could experience opportunities they would not otherwise be exposed to. This would in turn would enable more disadvantaged children to understand and consider emerging job opportunities, such as those related to STEM.

There was also recognition of the need to equalise disparate opportunities across different regions of Scotland. Primary school teacher 2 shared a personal story to explain how access to technology-related opportunities was noticeably different in an urban school relative to another school in a more rural region. The Education Scotland Official 1 also commented that “in terms of career education and that

geographical stuff... we need to be clever about it and it needs to be equal access to these things.” While showing awareness of differences in access to opportunities with technology, this awareness did not translate into an understanding of how the automation of occupations may contribute to new career risks across groups.

The influence of parents and other role models were also cited as pertinent factors in preparing children for their future careers. Agreeing with Career Adviser 2, Career Adviser 3 suggested that: “still young people to this very day, they still felt pressured into doing what their parents want them to do.” Primary school teacher 2 broadened this point by mentioning the moderating variable of social class in determining the influence of the child’s home environment: “what they see at home will be different to a child of a different class or who has parents who do different jobs.” Though parental influences were identified by the interviewees, this observation was not connected to the possibility of certain parents, who may hold occupations at higher risk of automation, passing on corresponding goals and values to their children – as indicated in Study One.

5.6.4 Theme 4: Job change learning expands horizons

The final two themes explore the second research question concerning the practical opportunities and challenges stakeholders face in addressing automation and job change with children. A common viewpoint expressed by interviewees was that supporting children’s learning on automation and job change could function as a basis for expanding their career horizons. The Education Scotland Official 1 explained how educating children about the changing world of work could be a source of inspiration. It was suggested that “far more excitingly is to make people aware by showing them examples; make them aware of the transient nature of the labour market.” It was reasoned that early learning experiences exploring technology

and job change would help lead children to discover new and intriguing career possibilities, concluding “there is actually quite a lot out there for me.”

Career Adviser 4 explained that learning experiences on emerging careers can help to foster children’s career exploration: “if you can sort of drop that little breadcrumb to them I think it gives them a definite thing that they can then go home discuss it with their people... and it's an excellent opportunity for them to then do their own sort of follow up and their own sort of research on it and find out more themselves.” A key point to affirm here is that whilst learning about different jobs has historically been important, evoking the idea of accelerating automation and job change could provide the unique opportunity to trigger young people’s curiosity to reflect on the nature of jobs, as well as the new possibilities resulting from changes to the makeup of occupations and job markets.

To help children prepare for the changing world of work, interviewees were widely of the view that it would be beneficial to start engaging children in these career topics from primary school or earlier (with several interviewees suggesting preschool or around 3 years old). A frequent justification for this proposal referred to younger children’s greater openness to new career experiences and the possibility to intervene before children increasingly narrow their career options. Primary school teacher 1 elaborated on this point: “I think teaching them that the world is changing and what the different priorities are or what it might look like or what might be important when they're older I think it's important as well, so they're not kind of stuck thinking policeman, farmer, hairdresser.” Career Adviser 1 suggested how early scaffolding of career concepts has been beneficial in this regard:

In the school process [when] you're engaging with the younger people, the more they threw themselves into the activity. As you started to get up to the later years with the Lego robots, people were starting with defined ideals or what they were good at and where they wanted to be... So, the earlier we introduced new concepts and new ideas to young people consistently, the more open they're going to be different concepts as they come up to high school.

Other interviewees highlighted the need to simplify new career concepts for those in the early years of education. Career Adviser 1 stated: "it's not [that] you introduce higher level concepts, but very basic concepts at an early age." The DYW Official 1 suggested using early career learning and deliberate play to highlight different career possibilities:

I suppose it's not necessarily about being very prescriptive... but about thinking about some of the things that are done just now; purposeful play and talking about things and maybe how the toys relate to industry.

Interviewees also stressed the importance of providing a broad range of realistic career experiences to children. The DYW Official indicated: "if you're teaching that from a young age, then kids have had exposure to lots of different sectors and lots of different things." Primary school teacher 2 elaborated on this point by referring to an online animal quiz activity produced by Skills Development Scotland, explaining that: "[it] was really, really, helpful in giving them a range of different job opportunities and a lot of the children haven't thought about before, and they spent a lot of time from that quiz researching the jobs further." The expansion of children's career options could have benefits for their future career success given that their preferred option(s)

may change or be displaced due to increasing job automation. However, it may additionally be important for stakeholders to support children's learning of the reasons and principles underlying automation and job change. As proposed in Study Two, with this understanding children could be better placed to comprehend the nature of job change and deduce likely changes within occupations and job markets.

Many practitioners reported using career representatives to model emerging career opportunities to children. Primary school teacher 1 explained that some technology programmes were used to show rural students new digital opportunities: "there's one called Tech You Can that I'm really interested in, and which is not just aimed at women, but there's women represented in it... it's all about the sort of tech industries and stuff. I think that's one that I couldn't get anyone local in for because of our geography." Primary school teacher 2 added: "I had an engineer come in and he spoke about how there's a lot of men that work in his industry and the importance of women." Practitioners' selection of career role models was often made on the grounds of personal characteristics such as gender, together with representing both emerging (i.e., AI-based technology jobs) and established sectors (e.g., police and army). The challenge for practitioners, however, could also be to use the topic of automation and role models to extend children's thinking beyond existing or emerging job opportunities to probe the reasons underlying job change itself.

5.6.5 Theme 5: Managing uncertainty and information demands

Whilst recognising the benefits of providing career role models to help children prepare for the changing world of work, the interviewees acknowledged some practical challenges in finding role models who could represent emerging occupations. The DYW Government Official 1 explained how children may lack role models and information to pursue emerging occupations:

[some] may have aspirations to go and work in the digital field, but you don't know anybody at all around you that works in that industry... The emerging world of work and new things that are out there, there's not necessarily a lot of information to go on because if it's a completely new job then you've got nobody to learn of what that job is, what it looks like, what the expectations of you are.

Another challenge for teachers and career educators was raised with respect to keeping abreast of rapidly evolving information on the labour market. On this point the Career Education official remarked that practitioners: “need to keep up to date with labour market information.” In contrast to issues of information scarcity, a possible challenge of information overload was also raised. The DYW Official 1 expressed the view that: “[there is] the challenge of being potentially too much information, because I think if you're overloading kids with information about these various different opportunities they've got for the world of work.” The interviewee went on to explain that the timing of information was important, such as in cases where an information overload may negatively impact students prior to making subject choices or taking exams.

A further challenge raised by the interviewees referred to children's possible difficulties comprehending the speed of technological and workplace change. The Programme Manager indicated that: “It's quite difficult for them to understand just the rate of change... So, I think that's why we talk about the skills. That's why we talk about the transferable skills.” Though this emphasis on widely applicable skills may serve as a partially useful shorthand to help children with the challenge of comprehending accelerating job change, stakeholders did not suggest that this career education approach would be extended to engage children in thinking about

the reasons and principles underlying automation and job change (e.g., why specific task or skillset changes are likely in different industries). This may leave children and adolescents less able to discern some of the more nuanced and complex changes resulting from automation, such as how routine and some non-routine tasks and occupations can be automated.

When discussing emotional challenges some children may experience in learning about the changing world of work, the STEM Engagement Adviser shared a story to illustrate the issue:

I was with a group who will be potentially impacted with our onshore wind farm just because they're quite near to it. And one of them, a P6 pupil actually, asked the question: Well, what's going to happen to my dad's job because he works at [name of gas company]? ... So, they obviously are worried about the transition and the changes of jobs, but nobody can give them an answer on that.

Expressing a similar sentiment, Primary school teacher 2 explained the possible emotional challenge stemming from “the unpredictability of the world of work and preparing these children for jobs that we don't know are gonna exist.” The DYW Government Official 1 also cited the emotional challenge children may feel due to unknown career changes. It was suggested that: “if you're moving into space where you have never been working or learning about all these different things and you're thinking to yourself I don't know how I'm going to cope with this.” Conversely, one policymaker believed teaching children about automation and the changing world of work was not likely to present any emotional challenges for children. Education

Scotland Official 1 remarked that: “Would it be scaring them? Would it be manipulating them? I can't see it.”

Interviewees explained there was a growing need for teachers to receive training in providing career education and supporting learning on the changing world of work. Primary school teacher 1 indicated: “You're in your own bubble and it would be great to know what these kids [could do] ... I think you know we need training in order to guide the young people.” Education Scotland Official 1 reaffirmed the idea that teachers could benefit from career education training, including starting in initial teacher education programmes: “They need to be continuously exposed to that. In fact, it needs to be woven into teacher education, you know, from the very early stages, so that there is a firm understanding.”

5.6.6 Summary of findings

Findings from this thematic analysis revealed a range of conceptual and practical challenges and opportunities Scottish career education stakeholders may face in educating children for the changing world of work. From a conceptual standpoint, career documents and stakeholders both emphasised a conception of automation as creating job opportunities rather than resulting in the mass elimination of jobs. Yet, with some accompanying nuance, certain job types and occupational tasks were understood as being increasingly susceptible to automation. Despite also recognising average group differences in young people's career preferences and pursuits, policymakers and practitioners did not draw the conclusion that automation and job change may contribute to differential career risks across groups.

Though stakeholders stressed the importance of meta/general skills and helping children prepare for multiple career transitions, there remain implicit attempts to use

person-occupation matching approaches (e.g., to encourage more students into STEM fields). Alongside these approaches, there could also be scope to foster children's understanding of the reasons and principles underlying job change. From a practical perspective, stakeholders suggested learning about technology and job change could function as a potential source of inspiration for children's career development. However, issues of future anxiety, cognitive demands, and a scarcity of role models/information were mentioned as potential challenges in supporting children's career preparedness.

5.7 Discussion

This case study set out to explore the conceptual and practical complexities Scottish career education stakeholders face in supporting children's preparedness for automation and job change. An important reason for doing so was to identify and examine possible inconsistencies and tensions in how career education stakeholders understand and support children's preparedness for a changing world of work. In the following sections the study findings are discussed in relation to the career learning mechanisms and environmental supports and barriers specified in SCCT.

Contemporary literature on job automation and results from the two prior studies are also used to inform the discussion. Implications for career theory are raised, as well as recommendations for improving career education policymaking and practice with children and adolescents.

5.7.1 Conceptualising automation and job change

In academic literature and various media outlets, conceptions of future job automation have ranged from emphasising the possibility of mass displacement of jobs to the job creating potential of technology (Arntz et al., 2017; Frey & Osborne, 2017; World Economic Forum, 2020). More in accord with the latter, findings from

the thematic analysis indicated that automation was primarily conceived of as creating new job opportunities rather than the mass displacement of jobs. This framing may have certain advantages given that recent research suggests many young people are not confident they can secure job opportunities in the future due to automation trends (Speakers for Schools, 2018; WorldSkills & OECD, 2019). SCCT suggests that individuals' perception of environmental barriers, such as job market developments, can influence their career-related beliefs, goals, and preparedness (Lent, 2013b; Lent et al., 2002). Presenting children with a more optimistic conception of future job opportunities, both in policy and practice, may therefore help to minimise perceived career barriers among children. It may also serve to raise the self-efficacy beliefs and outcome expectations children develop for pursuing their preferred career paths (Lent et al., 2000).

Policymakers and practitioners' conceptions of automation were nonetheless multifaceted. Stakeholders additionally referenced the uncertainty of future automation and the possible consequence of technology displacing certain types of occupations, such as routine physical and cognitive roles. They also explained how some non-routine tasks within occupations could be subject to automation, while other tasks will continue to be carried out by humans. Holding a more nuanced conception of the changing world of work may enable policymakers and practitioners to aid children's and adolescents' preparedness for the unique changes in occupations and job markets, and help to develop relevant career supports (e.g., building career networks and resources) (Lent, 2018).

Nevertheless, adopting a relatively complex and cautious account of automation alongside a positive emphasis on the job creation consequences of new technologies, may mean that some children could become confused or misinterpret

the meaning of the contrasting messages. For example, a young person pursuing a job in accountancy may find it difficult to develop positive or realistic outcome expectations. This is because the contrasting messages may create doubt in the young person's mind about whether this occupation is likely to be readily attainable in the future, or whether, due to its routine tasks, it is likely to be at high risk of automation (Frey & Osborne, 2017). As discussed further on, some of these concerns about conceptual complexity or misunderstandings might be overcome through content scaffolding approaches.

Various job sectors were highlighted as likely to be increasingly prominent in the future. Many of these sectors, including social care and science and technology occupations, are predicted to be less susceptible to automation (Manyika et al., 2017; OECD, 2018). Other sectors mentioned by Skills Development Scotland staff and documents, such as construction, are however predicted to be at higher risk of automation over the coming decades (Frey & Osborne, 2017). Thus, there was not an attempt to differentiate between the short-term job opportunities in sectors such as construction and manufacturing (Office for National Statistics, 2023), with the longer-term predictions of increasing job automation in said sectors (PwC, 2018). Making a clear conceptual distinction between short-term and long-term job trends could be an important issue for policymakers due to the accelerating speed of technological development and resulting job change. By making clearer delineations, career policy, including school curricula, may better aid career practitioners and teachers in supporting current and forthcoming generations of children prepare for the evolving challenges in different sectors.

Without dissuading children and adolescents from pursuing occupations in high-risk sectors such as construction, it is possible that critical exploration of both the short-

term and longer terms trends in a sector may help young people in various ways (Lent, 2018). It may aid them in exploring emerging roles or long-term job opportunities and skills with higher returns. This critical engagement may also facilitate interactions with industry insiders who can provide insights on career attainment challenges and future possibilities in the sector (Lent, 2018). Similar to the case of children learning about climate change, despite the fair degree of uncertainty, stakeholders may consider supporting children's critical engagement with future job change to uphold their rights to explore issues relevant to their future.

Compared to other sectors, skills and occupations in the digital sectors were frequently affirmed by stakeholders as increasingly important. The reason for this conclusion, which is consistent with some recent research (Bughin et al., 2018; Ubalde & Alarcón, 2020), was the idea that the continued development and implementation of new technologies will require new roles to manage, service, and/or to work in tandem with machines. The conception of a closer entanglement between technology and workers could be used to stimulate children's thinking about their relationship to technology. By encouraging children to explore how technology, work, and people are not entirely separate entities, but are intimately linked and are in certain ways co-evolving to achieve wider goals, children may develop new modes of thinking about their career and life preparedness. Equally, it is also important for stakeholders to not promote an overly generalised view about the creation of new digital jobs and skills. As some emerging technologies could potentially reduce demand for certain digital jobs and skills as well (e.g., coding) (Chui et al., 2022), career education provisions and stakeholders can help to foster a more nuanced understanding of digital job opportunities and skill requirements.

5.7.2 Reconciling person-occupation alignments with general career skills

Over many decades a commonly used approach by career professionals helps children or adults align their interests, values, and skills with specific occupations. This process includes opportunities for self-exploration, occupational learning, and subsequent person-occupation comparisons or matches (Lent & Brown, 2020; Parsons, 1909). This linear approach, which is also a part of SCCT, to some extent assumes a person can pursue, attain, and maintain a career in a good-fitting occupation over an extended period of time (Lent, 2013a). However, in this case study both policymakers and practitioners reaffirmed the idea, which is also supported by recent research (Chudzikowski, 2012; Sullivan & Al Ariss, 2021), that young people are increasingly likely to experience multiple career transitions or a portfolio of careers. This implies an assumption that there are likely to be more misalignments between pre-planned person-occupation pairings. Rather than explicitly focusing on this process, stakeholders placed emphasis on the importance of promoting meta-skills and career management or adaptability resources to help children adapt to shifting career conditions and meet new skill demands.

However, stakeholders' emphasis on promoting meta skills and career management skills was in possible tension with other ideas of supporting children toward specific careers, such as STEM occupations (i.e., providing children with STEM-specific information and learning experiences to facilitate a possible match with STEM occupations). In addition, stakeholders explained that the children they work with often exhibit dispositions toward certain career options and it is therefore useful to recognise that they are likely to view some options as more viable than others. As Lent (2013a) has pointed out, children and adults cannot readily reinvent themselves as potential future workers across a broad spectrum of occupations (e.g., scientist,

care worker, plumber). Because certain career options will be more appealing to children based on their dispositions, acquired skills, interests, resources, and values (Gottfredson, 2002; Lent, 2013b), there remain reasons for career policymakers and practitioners to support children in finding and preparing for specific career options which are more personally suitable, without also assuming a good-fitting match will remain so indefinitely (Lent, 2013a).

There are also certain cases in which person-occupation alignments are both potentially plausible and beneficial. In cases such as supporting young people toward jobs or sectors predicted to grow in future, such as STEM fields (World Economic Forum, 2020), it is possible that a sustained match between person and occupation is more feasible to achieve. However, in other instances, such as a person who is more inclined toward routine manual or cognitive roles, the usefulness of employing a person-occupation matching approach could be more limited. Though some have argued that a focus on facilitating career adaptability rather than career decision making is a more optimal way for career theory and practice to proceed in response to ongoing job change (van Vianen et al., 2009), it is conceivably better to make use of both concepts and to aid practitioners in understanding the cases in which person-occupation alignments are more feasible.

Accordingly, it is the situated judgement of the career educator or teacher which is particularly important (Biesta, 2023). The capacity to know when a person-occupation alignment process is more viable (e.g., depending on the proclivities of the person and the changing availability of job opportunities). To discern the balance of occupation-specific learning and general career resources which can both equip the person(s) to navigate possible career transitions and uncertainty, while also enabling informed career decision making to achieve a good-fitting match for an

extended (if indefinite) duration of time. Career theory and research could therefore be directed toward investigating the cases in which person-occupation alignment approaches can be more or less usefully applied to help young people find and/or secure good-fitting or socially desirable careers.

Career stakeholders' conceptualisation of meta skills and career management skills may also omit something important. While these general capacities may allow children to adapt to career change and meet generic skill demands, they do not in themselves enable young people to understand the nature of job change or the principles and reasons underlying future job automation. Stemming from insights in Study Two, a meta understanding of job change may provide young people with the reasoning tools and heuristics to deduce likely changes within occupations and job markets. By developing an understanding of how technology could affect certain occupational tasks and not others (e.g., such as tasks which are not well-defined problems or require extensive social intelligence), or how socio-economic factors could mediate the adoption of new technologies in workplaces, young people could be better prepared to anticipate future job changes and make more informed career planning decisions.

5.7.3 Understanding the implications of automation for different groups

Findings from the thematic analysis showed there was a broad recognition among stakeholders that there are average group differences in the career pursuits of young people. However, Scottish career policymakers and practitioners conceived automation would impact children universally and would not contribute to differential impacts across groups. These two sets of viewpoints may potentially produce inconsistencies in stakeholders' conception of job automation. By suggesting that automation will impact certain types of jobs more than others (e.g., lower skilled jobs

and manual labour roles), while also affirming that certain groups tend to disproportionately pursue these different types of roles, stakeholders may be operating under the misapprehension that homogeneous rather than heterogeneous group impacts are likely to result from automation. Yet, evidence presented in Study One indicates that different groups of children may encounter differing automation-related career risks. These risk differences may span the group categories of gender, ethnicity, social class, and parental occupation.

Conceptions about the impacts of automation on different groups of children are important to clarify. Because it is not always practically feasible to provide individualised career instruction to every child or to make policy and programme decisions without reference to general features of a population (e.g., low-income groups tend to obtain lower income occupations), career policymakers and practitioners can benefit from enhanced understanding of the broad group impacts of automation. This may allow stakeholders to better identify those at increasing risk and to design policies and programmes to help school students prepare for the more group-specific career challenges and opportunities they may encounter.

Nonetheless, it is important to acknowledge that addressing the group-related impacts of automation could be a complex affair. Because technology can increasingly affect both routine and some non-routine occupations (including certain higher status roles), all groups of children are likely to be affected by automation in different respects. Understanding and addressing this complex web of group challenges will pose a problem to career stakeholders and could be difficult to manage in tandem with other group-related considerations (e.g., reducing present-day career stereotyping). In some cases, these different priorities could potentially be combined into a unified solution. Some of the career stakeholders' existing group-

related approaches, such as encouraging more girls to pursue STEM roles and boys to consider traditionally female occupations, are consistent with the predicted growth of STEM jobs and socially intensive occupations (OECD, 2018; World Economic Forum, 2020). The topic of automation could be used by stakeholders as a means by which to inform and motivate young boys and girls to pursue gender non-traditional occupations and skills due to their future prominence.

Case study findings also showed several stakeholders referred to regional differences in children's career education and job opportunities. Regional differences in job opportunities may continue or evolve due the varying technological adoption time lags within a country or across countries more broadly (Manyika et al., 2017). As pointed out by stakeholders, in a more rural or remote part of the country, new technologies may take a longer time to be implemented in workplaces and schools. This could create different career learning opportunities and local job market conditions. Using the concepts of SCCT, these different contextual conditions can result in unique environmental barriers (perceived and actual) as children pursue and prepare for their careers (Lent & Brown, 2019; Lent et al., 2000). It is therefore important for career policymakers and practitioners to be aware of these evolving environmental barriers and potentially tailor career provisions for children in different regions. This may include helping children and adolescents develop specific career networks, skills, and barrier coping strategies corresponding to their local career needs (Lent & Brown, 2020; Lent et al., 2002).

Various stakeholders also highlighted the influence and role parents can play in shaping children's career choices. Although the career documents and stakeholders mentioned the importance of involving parents and inviting them career events in schools, the ramifications of parental influence on children's career preparedness for

automation and job change were not specified. However, findings from Study One suggest school students with parents holding a job at high risk of automation may be more likely than their peers to also hold a high-risk career aspiration. This finding may raise a dilemma for policymakers and practitioners. Partnering with parents to support children's career preparedness could, in some cases, unintentionally result in more children with parents holding high-risk occupations pursuing similarly high-risk careers (or skillsets) as their parent(s). It is therefore possible that parents value as a career role model for their children may involve certain limitations, particularly as new occupations emerge from technological developments.

Though partnerships between career educators and parents should not be terminated, it is important for these collaborations to be responsive to possible automation-related career risks. Policymakers could carefully devise initiatives to raise awareness of these potential new career risks among parents without sending a discouraging message that their jobs are destined for automation. Career practitioners and teachers could also encourage a diversification of career role models (e.g., invited industry experts or social media influencers) to help children consider a broader range of career options and acquire supports to more easily transition into fields which are not well represented in the home environment.

5.7.4 Practical opportunity: Using job change to stimulate career curiosity

Regarding the second research question, findings from the case study revealed that Scottish career education stakeholders reported various practical opportunities and challenges. Stakeholders expressed the view that exploring the topics of automation and job change could serve to spark children's curiosity and inspiration for investing in their career preparedness. New technological developments and the consequences for the world of work were purported to generate intrigue and

stimulate young people's career learning. In past generations occupations and job markets were relatively stable (Savickas, 2000). Now, as technological and occupational change accelerates, career practitioners, teachers and other stakeholders could take advantage of the novelty and uncertainty created by ongoing change to inspire children to explore emerging careers options and requirements.

Inspiration and motivation play an important part in occupational learning and informed choice making. SCCT and SCT reiterate the importance of motivational factors in supporting children's learning and self-belief formation (Bandura, 2001; Lent, 2013b). These learning experiences and self-efficacy beliefs can in turn contribute to children's career goals and preparedness for their career pathways (Bandura et al., 2001; Lent, 2013b). Consistent with some of the stakeholders' observations, recent experimental evidence studying the impact of an educational intervention focused on career change and adaptability reported statistically significant increases in children's career curiosity, hope, and exploration compared to those in a traditional career guidance programme (Ginevra & Nota, 2018). While more research is needed in this area to reproduce such results and examine the moderating effect of cultural and contextual factors, there are possibilities for practitioners to trial and learn from how automation and job change can be used to support children's career curiosity and preparedness.

5.7.5 Practical opportunity: Early career learning experiences expand horizons

Stakeholders reported benefits in starting career education provisions in the early years of schooling or pre-school to broaden children's and adolescents' career horizons. The reason for starting career education in preschool was based on the observation that younger children are more often open to exploring new career opportunities, including those which may be gender counter stereotypical. Because

children's preferred career options may be increasingly subject to change due to the impacts of automation, widening their pool of plausible alternatives can help them to transition to new career or educational paths more easily should they encounter insurmountable barriers (Lent, 2018). SCCT suggests that younger children, by accumulating a broad range of career learning experiences which positively influence their self-efficacy beliefs and outcome expectations, could be more prepared to pursue alternative career paths should they encounter environmental barriers restricting their preferred career choice(s) (Lent, 2013b; Lent & Brown, 2019).

Nevertheless, in SCCT it is not explicitly specified whether preadolescent children's career beliefs and goals are relatively more or less malleable. Indeed, despite the possible reasons presented by career stakeholders and others in favour of early career learning, to-date there has been little empirical research to verify the comparative advantage of starting career education in the early years of schooling (Kashefpakdel et al., 2018). Because significant doubt remains in this area, it is important to advance career theory and research into this issue to examine whether and how preadolescent children's career beliefs and options can be expanded to meet the future career possibilities and barriers resulting from job automation.

Findings from this case study suggest stakeholders were aware of some possible practical challenges of early career education. To support younger children who may experience difficulties in understanding the complexity of certain content on careers, several stakeholders specified the importance of scaffolding career concepts to incrementally introduce children to more complex career ideas. These ideas were not, however, explicitly linked to the principles underlying automation and job change. Introducing concepts such as the automation of routine and some non-

routine occupations, for instance, may be more suitable once children have acquired an understanding of the idea that occupations are comprised of different tasks. Research suggests this knowledge is increasingly evident as children progress through primary education (Ferrari et al., 2015). Part of the evolving role of practitioners and teachers may include helping children to gradually learn how to deconstruct occupations, to understand their unique relationship to technology, and discover how they may evolve through the combination of technological and socio-economic forces.

Supporting children's and adolescents' career preparedness through the school curriculum was additionally suggested as an important opportunity by the career stakeholders. This can include highlighting connections between subject matter and emerging career opportunities or requirements (Chambers et al., 2018). Yet, a practical issue in this regard may involve the challenge of keeping the school curriculum and teachers' knowledge abreast of rapid developments in technology and the world of work. Because the skills and tasks within occupations are speedily evolving, such as the growing prominence of social skills in technology roles (Colombo et al., 2019), teachers, such as those interviewed in this study, may struggle to draw relevant connections between subject matter and future occupational or job market demands. As an example of making relevant connections, purposeful play was suggested by some study participants as a means by which young children could explore how different toys relate to various industries. This may include investigating how technologies in the toys can perform different work-related tasks.

5.7.6 Practical opportunity: Role models for changing occupations

Another important opportunity emphasised in the Scottish career education documents and by interviewees was the provision of career role models, particularly those with personal characteristics corresponding to groups underrepresented in certain fields (e.g., female role models for STEM jobs). The presentation of personally identifiable models, as proposed in SCT and SCCT, affords children the enhanced possibility of learning through demonstrations and imitation (Bandura, 2001; Lent et al., 2002). Selecting a model who closely imitates the skills and dispositions relevant to new occupational requirements could enable children to develop corresponding beliefs and skillsets. However, presenting children with identifiable models for newly emerging occupations may frequently be a challenge since the characteristics of the occupation may not be well known or there could be a lack of available role models to invite.

Teachers and career practitioners in this case study explained that finding future-relevant career role models in more remote or deprived communities can often be a challenge as globalisation advances and new occupations are often located in urban areas. For example, Scottish children from rural communities with an interest in new occupations in the digital sector were reported to lack relevant career role models due to the high concentration of these jobs in more urbanised or affluent regions. To minimise these discrepancies between children in rural and urban areas, schools and career practitioners based in more remote communities may make use of digital technologies (e.g., videoconferencing, virtual reality, and augmented reality) to expose children to a broader range of workplaces, job opportunities, and career role models (Hidayat & Alfian, 2020).

5.7.7 Practical challenge: Managing anxiety and uncertainty

Policymakers and practitioners in this case study identified a range of practical challenges associated with supporting children's learning about the changing world of work. An emotional challenge suggested by interviewees was the possibility for inducing anxiety among some children. This anxiety was suggested to stem from two sources. The first was from learning about future job losses due to automation and the supplementary challenge of facing multiple career transitions. The other source of anxiety was said to derive from the lack of job information and uncertain expectations in preparing for future occupations and job markets. Similar reports of anxiety concerning future job change have also been found in recent surveys involving adolescents across various countries (Speakers for Schools, 2018; WorldSkills & OECD, 2019).

Because anxiety and uncertainty can affect children's learning and their development of positive self-efficacy beliefs and outcome expectations, which are important for their career aspirations and preparedness (Bandura, 2001; Bandura et al., 2001; Lent et al., 2002), it is important for stakeholders to provide relevant emotional support to minimise possible stress and perceived environmental barriers related to automation and job change (Lent, 2018). A possible approach may include communicating stories of young people's successful attempts to navigate career change, providing encouragement to explore new career opportunities, and building career support structures to reduce the career anxiety children experience (Lent & Brown, 2020).

5.7.8 Practical challenge: Comprehending job change

A further challenge identified by stakeholders was suggested to involve children's potential difficulty in comprehending the speed and complexity of change in the world

of work. As previously mentioned, rather than presenting children with a substantial amount of occupational information, career policymakers and practitioners were keen to promote meta skills and career management skills as capabilities which are widely applicable to future career demands. It was proposed that this could reduce the cognitive demands on young people. Some research indicates these general career resources (e.g., career adaptability) can be readily developed by children and could help them to manage future career uncertainty (Ginevra & Nota, 2018). This approach may, however, involve several limitations. First, the learning of these general skills does not enable the young person to understand the nature or nuances of the changes taking place in technology and occupations. Understanding the reasons why job markets, occupations, tasks, and skill requirements may change requires a comprehension of the relationship between technological capabilities and different job types, as well as the mediating role of socio-economic factors.

Additionally, because meta skills are generically applicable skillsets, they do not provide young people with the means by which to deduce occupation-specific changes or to identify new industry-specific barriers and supports to form and implement career choices. Whereas a meta understanding of job change may overcome these shortcomings without also burdening the young person with having to memorise extensive amounts of occupational information. This capacity comprises of an understanding of the reasons and sets of principles underlying automation and job change (i.e., how well-defined linear problems or tasks in structured environments can be more easily automated). By learning and applying these principles and heuristics with informed judgment, young people could make reasonable (if imperfect) deductions of the likely changes in occupations and job markets to aid their career decision making and preparedness. Since these

principles involve a fair degree of abstract reasoning and nuance it is likely they would need to be gradually learnt over the young person's childhood. Research into the development of this capacity could thus be important.

5.8 Study limitations

There are several limitations of this case study to note. First, because this case study explored public documents and the perspectives of a sample of policymakers, career practitioners, and teachers making up the Scottish career education system at a particular moment in time, caution should be taken before generalising the findings to other contexts or time periods (Yin, 2017). This is important due to the possibility that as technology rapidly advances and predictions about the future world of work may be updated or revised, the conceptions career policymakers and practitioners hold could be subject to change as they learn about these developments.

Furthermore, as this study was conducted during a period of relatively significant media coverage dedicated to new digital technologies and job automation (Chui et al., 2022; PwC, 2018), it is plausible that the attitudes and conceptual insights expressed by stakeholders in this study may not be replicated in the near future or may vary markedly in countries less saturated by mass media.

Another possible limitation relates to the study sample. As convenience and purposive sampling techniques were used to select participants for the interviews and focus group, it is possible that selection biases may have contributed to a sample that was skewed towards participants with more background knowledge or interest in the topic of automation and job change. For instance, because some teachers volunteered to participate in the study after various schools in Edinburgh City Council were contacted via email, it is possible a self-selection bias may have produced a sample of teachers who possess more interest and/or awareness of the

topic than most teachers in the region (Leavy, 2017). While the number of participants involved in the interviews and focus group was relatively small compared to the total population of Scottish schoolteachers and career practitioners, the diverse age ranges, genders, and geographic locations of the participants may still have afforded a fairly broad set of stakeholder perspectives (Creswell & Creswell, 2017).

Through engaging in a process of reflexivity, it was possible to identify personal beliefs, preferences, and knowledge about the topic which may have influenced the research process (Whitaker & Atkinson, 2019). For instance, when asking participants about the potential impact of automation on different groups of young people, some may not have fully understood the question or felt led toward giving a particular answer (e.g., I don't want to treat groups of children differently). To minimise such occurrences, the researcher would seek further clarifications from the participants by restating their answer back to them and checking whether they agreed with the formulation. Also, due to my prior knowledge of the results from studies 1 and 2 and continued use of SCCT, some of the themes identified in the analysis may have omitted relevant insights beyond the boundaries of these frameworks. To reduce this possibility discussions were had with other researchers about differing interpretations of the data.

5.9 Conclusion and implications

This case study of the Scottish career education system explored the conceptual and practical complexities stakeholders face in supporting children's career preparedness for the changing world of work. Findings showed policymakers and practitioners conceptualised automation as creating new job opportunities rather than resulting in the mass elimination of jobs. In contradistinction, more cautious

conceptions were also raised about the uncertainty of job automation and possibility for routine occupations and some non-routine tasks to be replaced by machines. Despite acknowledging persisting group differences in children's career preferences and pursuits, findings suggest policymakers and practitioners did not draw the conclusion that automation and job change may contribute to differential career risks across groups.

5.9.1 Implications for policymakers

In advancing career education policy, it is important for policymakers to provide clear and comprehensible clarifications of the differing impacts of automation on occupations and the possible career implications for different groups. Due to the accelerating speed of automation, there is also reason for policymakers to distinguish between short-term and longer-term job trends to aid young people's informed career planning. Findings from this research further suggest that children and adolescents may face both actual and perceived environmental barriers related to automation and job change. Along with highlighting actual barriers such as new job market constraints, policymakers can also develop curricular and policy documents to aid stakeholders in addressing some children's potentially negative perceptions and feelings of uncertainty regarding automation and their future career prospects.

5.9.2 Implications for career practitioners and schoolteachers

Supporting children and adolescents to prepare for multiple career transitions and adapt to ongoing job change were recognised as important priorities by practitioners and teachers. Yet, while placing an emphasis on career adaptability and meta skills, there remained an inexplicit use of person-occupation matching processes to encourage children toward emerging sectors (e.g., STEM) and to build on children's

developing dispositions toward certain career options. However, to also facilitate a comprehension of the more nuanced aspects of automation, teachers and career practitioners can support children's meta understanding of job change to raise their awareness of the principles underlying job change. Through this understanding young people could be more capable of discerning the likely consequences of automation within different occupations and job markets.

Engaging children in learning about job change was suggested to be a source of inspiration for children's career preparedness due to the novelty and intrigue generated by new technologies reshaping the world of work. Practitioners and teachers may try to build on this idea by stimulating children's career learning through critically exploring new technological innovations in different industries (Lent, 2018), as well as providing diversified career role models and realistic learning experiences corresponding to emerging occupations. In addition, a range of practical challenges were also specified by stakeholders. These included managing career anxiety among some children due to future career uncertainty and the changing availability of jobs. The cognitive demands involved in comprehending the speed and complexity of changes taking place in the world of work were also highlighted as challenges to overcome. To address these challenges, it is important to use content scaffolding approaches and for career education stakeholders to coordinate their activities to develop mutually reinforcing social supports that can foster children's career self-efficacy beliefs and barrier-coping strategies (Lent, 2018).

5.9.3 Implications for career theory

An important contribution of this study for SCCT was to reveal how automation and job change may function as both a perceived environmental barrier and a source of inspiration or support for children's career preparedness. This study adds to the

existing body of research on SCCT (Lent & Brown, 2019; Lent et al., 2000), showing that job change learning could play a role in positively shaping young people's career self-efficacy beliefs, outcome expectations, and perceived barriers (i.e., using the novelty and intrigue surrounding new technologies). Yet, there are also possible negative perceptions and beliefs associated with automation (e.g., uncertain future availability of jobs) among some young people which may impact their career preparedness and decision making. Additional findings from this study suggest that person-occupation matching approaches can be used more judiciously (e.g., in more select cases such as promoting STEM or emerging careers) and should be supplemented by a meta understanding of job change. Future research could help to examine the cases in which career practitioners and stakeholders could draw on person-occupation matching processes alongside supplementary approaches of engaging children in learning about the reasons and principles underlying job change.

5.10 Data availability

The datasets generated and analysed during the current study are available in the "Case Study of Scottish Career Education System" repository,

<https://doi.org/10.7488/ds/3856>.

6.0 Synthesis of Research Findings and Implications

6.1 Chapter overview

This concluding chapter provides a synthesis of the findings from the three studies. First, the overarching aim of the thesis is revisited. Next, findings from each study are synthesised in relation to different aspects of the overarching research question. These include the limitations of and supplements to traditional person-occupation matching approaches, emotional and cognitive complexities of learning about job change, practical issues, and the complexities of understanding and addressing group factors. Thereafter, contributions to theory/knowledge and recommendations for future research are discussed. Implications of the research are then specified for policymakers, career practitioners, schools and teachers, parents, and children. Finally, limitations of the thesis are discussed and concluding remarks are provided.

6.2 Summary of the overarching research aim and studies

This thesis set out to contribute to an understanding of the complexities of supporting children's career aspirations and preparedness for the changing world of work. Three consecutive studies were planned and conducted to address the following overarching research question: what are the complexities of supporting children's career aspirations and preparedness for automation and job change? Each of these studies responded to a distinctive aspect of the research problem. To first ascertain an evidence-based understanding of the differential and nuanced automation-related career risks different groups of children and adolescents may encounter, Study One addressed the following research question: what differences exist among school students and various subgroups in aspiring to occupations at technical risk of automation over the next few decades? Results indicated that various groups,

including adolescents, males, lower-income students, and parental occupation were associated with a higher likelihood of aspiring to occupations at risk of automation.

Following on from an analysis of these automation-related career risks, there was reason to suggest that while interventions could help to support children in aspiring to their future careers, commonly used intervention approaches may not be adequately addressing the emerging risks associated with automation and job change. Consequently, to gain insights and identify possible gaps in recent intervention approaches, Study Two explored the following question: in what ways are the approaches used in career aspiration intervention studies involving children and adolescents addressing changing career conditions? Findings from this review revealed that recent intervention approaches have largely not, through their objectives or learning content, addressed changes within occupations and job markets.

Analyses of the review findings indicated that there could be possible approaches and benefits to addressing automation and job change with children. But, due to the complexity of future automation, career education stakeholders may nonetheless face a range of conceptual and practical challenges in supporting children's career preparedness for a rapidly changing world of work. Accordingly, Study Three explored the conceptual and practical opportunities and challenges of supporting children's career preparedness for automation and job change in a specific context. By examining the perspectives of key stakeholders making up the Scottish career education system, various conceptual inconsistencies, practical challenges, and insights were identified. In the following section, findings from these three studies are synthesised in relation to different aspects of the overarching research question. These include the limitations of and supplements to traditional person-occupation

matching approaches, the emotional and cognitive complexities of learning about job change, practical issues, and the complexities of understanding and addressing group factors.

6.3 The complexities of supporting children's career aspirations and preparedness

6.3.1 Limitations of person-occupation matching processes

This thesis began by suggesting how the three step process of self-exploration, occupational learning, and person-occupation comparison or matching commonly used in career goal/choice interventions and theories may increasingly result in problems (Lent & Brown, 2020). Because it has become more common for a young person to experience multiple career changes and non-linear career trajectories (Chudzikowski, 2012; Sullivan & Al Ariss, 2021), any pre-planned alignment or match between a person and an occupation may be less likely to be realised or sustained (Lent, 2013a). Likewise, as new occupations are created and some pre-existing jobs are displaced due to accelerating automation and other socio-economic factors (Autor, 2015; Frey & Osborne, 2017), predicted or desired matches between persons and specific occupations could be less likely to occur. Findings from the three studies in this thesis offer new contributions to help further an understanding of this emerging problem.

Results from Study One indicated that a relatively small percentage of primary school students (around 7% aged 7-11) and moderate proportion of secondary school students (around 25% aged 17-18) expressed career aspirations at medium or high risk of automation. Although these estimates are subject to several uncertainties (e.g., speed of technological adoption and possible changes in young

people's career goals/choices in early adulthood), they provide some evidence to indicate that person-occupation misalignments resulting from future job automation could apply to a moderate proportion of young people. This means that, without taking account of accelerating job automation, processes to help match children to their preferred or good-fitting occupations could be increasingly less likely to achieve their intended outcome. Crucially, as revealed in Study Two, the matching approaches used in recent career aspiration interventions with children and adolescents have largely not addressed job change through their objectives and content, along with the nuanced risks associated with automation.

For instance, many intervention approaches found in Study Two, as well as similar approaches reported by stakeholders and career documents in Study Three, focused on broadening or raising the status of children's career aspirations. Yet, as accelerating automation may affect some higher status occupations (e.g., financial adviser, lawyer, and accountant) as well as lower status roles (Frey & Osborne, 2017; Manyika et al., 2017), intervention approaches which generically aim to raise children's career aspirations may not effectively prepare them for the evolving opportunities in future job markets.

This research therefore highlights that while accelerating automaton could present new career risks (e.g., possible unemployment, skill gaps, or financial costs) for many young people as they establish their career aspirations and choices, widely used intervention/matching approaches could be increasingly inadequate to aid young people in forming their career aspirations. The net result of not systematically addressing the nuanced and differential career risks associated with automation could also mean that new or existing group inequalities grow (e.g., lower income children not sufficiently developing automation-proof skills or aspirations).

Whilst traditional person-occupation matching theories and approaches are likely to have reduced value within the context of accelerating automation, findings from the studies nevertheless highlight certain cases in which these approaches may retain some benefits. Intended matches between participants' career aspirations and specific occupations, particularly STEM roles, were a focus of many intervention studies included in the systematic review. In these interventions opportunities for self-exploration and/or occupation-specific learning experiences were carried out with participants. Similarly, career education stakeholders in Study Three, while emphasising the importance of general career skills, still implicitly assumed the value of person-occupation matching approaches to encourage children to aspire and prepare for STEM careers and other emerging occupations. Because certain sectors such as STEM are predicted to become more prominent over the coming decades (Manyika et al., 2017; World Economic Forum, 2020), it is possible person-occupation matching approaches remain a viable option in such cases by supporting children's self and occupational learning in accord with the specific occupation/sector. However, as will be discussed in the next section, there remains some scope for approaches targeting emerging sectors such as STEM to also consider how certain tasks and skills within these roles could be subject to change. Collectively, insights from the studies suggest that there are important reasons for career theories and interventions to be more cautious in applying traditional person-occupation matching approaches with children in light of the significant and nuanced automation-related career risks identified. Nevertheless, rather than discarding person-occupation matching approaches entirely, there are possible benefits from more judiciously applying these approaches, particularly in cases such as supporting children's aspirations for emerging job opportunities/sectors. Selecting and using

person-occupation matching approaches more systemically could help children to prepare for and secure new opportunities within rapidly evolving job markets and to reduce career-related inequalities between different groups (e.g., gender or parental risk differences identified in Study One). These findings serve to elucidate some of the automation-related complexities of supporting children's career aspirations using traditional person-occupation matching approaches. In the next section, it is shown how such approaches could be more effectively supplemented to support children in forming their career aspirations and preparing for the changing world of work.

6.3.2 Supplementing person-occupation theories and approaches

Building on the insights and gaps identified in Study Two, it was possible to generate a supplementary career construct/approach which could address some of the limitations of traditional person-occupation matching approaches. In particular, findings from the systematic review revealed that recent interventions have largely provided sector-specific or multiple career learning experiences focused on occupations and job markets in their pre-existing form without supporting learning on how occupations could be subject to change in various ways. Even when focusing on emerging sectors such as new occupations in STEM, the intervention approaches typically did not encourage children to explore how the skill, task, or work environments of STEM jobs are rapidly changing. Yet, there is growing evidence to suggest that skill and task requirements are significantly changing across a range of occupations, such as increasing social tasks in technology roles (Bughin et al., 2018; Colombo et al., 2019; Ubalde & Alarcón, 2020).

To help children and adolescents develop skills, knowledge, self-beliefs, and goals that align with the future requirements of occupations, there was thus reason to modify or supplement approaches that assume static conceptions of occupations

and job markets. As an alternative, it was argued that supplementary approaches could promote children's learning about the dynamic changes underway in occupations and the multiple career changes they may experience. This may support young people to form outcome expectations, self-efficacy beliefs, and coping strategies to navigate new environmental barriers in order to attain their preferred career, to seek out emerging roles in industry, and/or implement career backup plans (Lent, 2018; Lent & Brown, 2020).

For stakeholders interviewed in Study Three, however, preparing children for the changing demands in the job market primarily involved promoting meta or general career skills (e.g., self-management, adapting, and social intelligence) rather than extensively conveying occupation-specific information or principles of job change. Career adaptability and meta skills are likely to be widely applicable capacities which children could develop to aid their preparedness for the uncertainty and demands of future job markets (Colombo et al., 2019; Santilli et al., 2017; Ubalde & Alarcón, 2020). Nonetheless, because young people will still need to form career-specific goals and choices (i.e., by rationally evaluating different options) which depends on acquiring and processing information about different occupations, general career skills cannot be treated as a singular solution. More crucially, due to the speed of technological developments and the nuanced changes across different occupations and job markets (PwC, 2018), such as how routine and some non-routine tasks within occupations could be automated (Frey & Osborne, 2017), general career skills and/or discrete occupational learning are likely not sufficient to enable young people to effectively discern and prepare for the complexities of future automation and job change.

To more effectively supplement these approaches based on the findings from studies two and three, it is suggested that young people could also acquire an understanding of the reasons how and why automation and job change are occurring and their different manifestations. This distinctive cognitive capability will be referred to as a *meta understanding of job change*. In distinction to career adaptability resources or meta skills, a meta understanding of job change involves comprehension of the reasons and principles underlying changes to occupations and job markets. It is argued that this cognitive capability comprises of acquired knowledge and a collection of heuristics or guiding principles by which children and adults can deduce likely occupational and job market changes without having to memorise an extensive amount of occupational information. These principles may include how technology can impact both routine and some non-routine occupations depending on their task makeup (i.e., more linear, well-defined tasks and tasks in more structured environments), as well as how new occupations could be created, and why the speed of technological adoption may vary across sectors or different regions/countries.

A meta understanding of job change may be an increasingly important cognitive capability for the reason that the accelerating speed and extent of job change makes it difficult for a person to retain extensive knowledge of job trends across multiple industries, or to learn by memory the evolving task and skill requirements in discrete occupations. Moreover, discrete occupational or job market knowledge may more quickly become redundant or require updating as new technological developments unfold and economic trends are revised (Arntz et al., 2017; Autor, 2015). A comprehension of the primary reasons and principles underlying job change could thereby reduce the cognitive burden on young people by equipping them with the

capability to deduce (if somewhat imperfectly) ongoing job changes using a smaller set of principles. This capacity can in turn support their career aspiration formation, planning, and identification of new supports and barriers relevant to their career decision making and preparedness.

While SCCT (and other career theories) specifies the role of environmental barriers such as job markets, along with supports to help people prepare for possible career change (Lent & Brown, 2019, 2020), the theory does not outline the important contribution of comprehending the reasons and principles underlying automation and job change. A meta understanding of job change can therefore add to (or potentially integrate within) theories such as SCCT, as well as those emphasising career adaptability resources (e.g., career construction) to help people more effectively prepare for the complexities of accelerating automation and job change.

To explain the construct in more detail, a multi-component framework was created and presented in Figure 12 below. The framework comprises of four key parts or dimensions. Each part refers to a distinct topic area, with examples of principles or heuristics underneath each topic area. These job change principles derive in part from the work of other scholars in the fields of automation and economics, as well as career development (Autor, 2015; Frey & Osborne, 2017; Sullivan & Al Ariss, 2021).

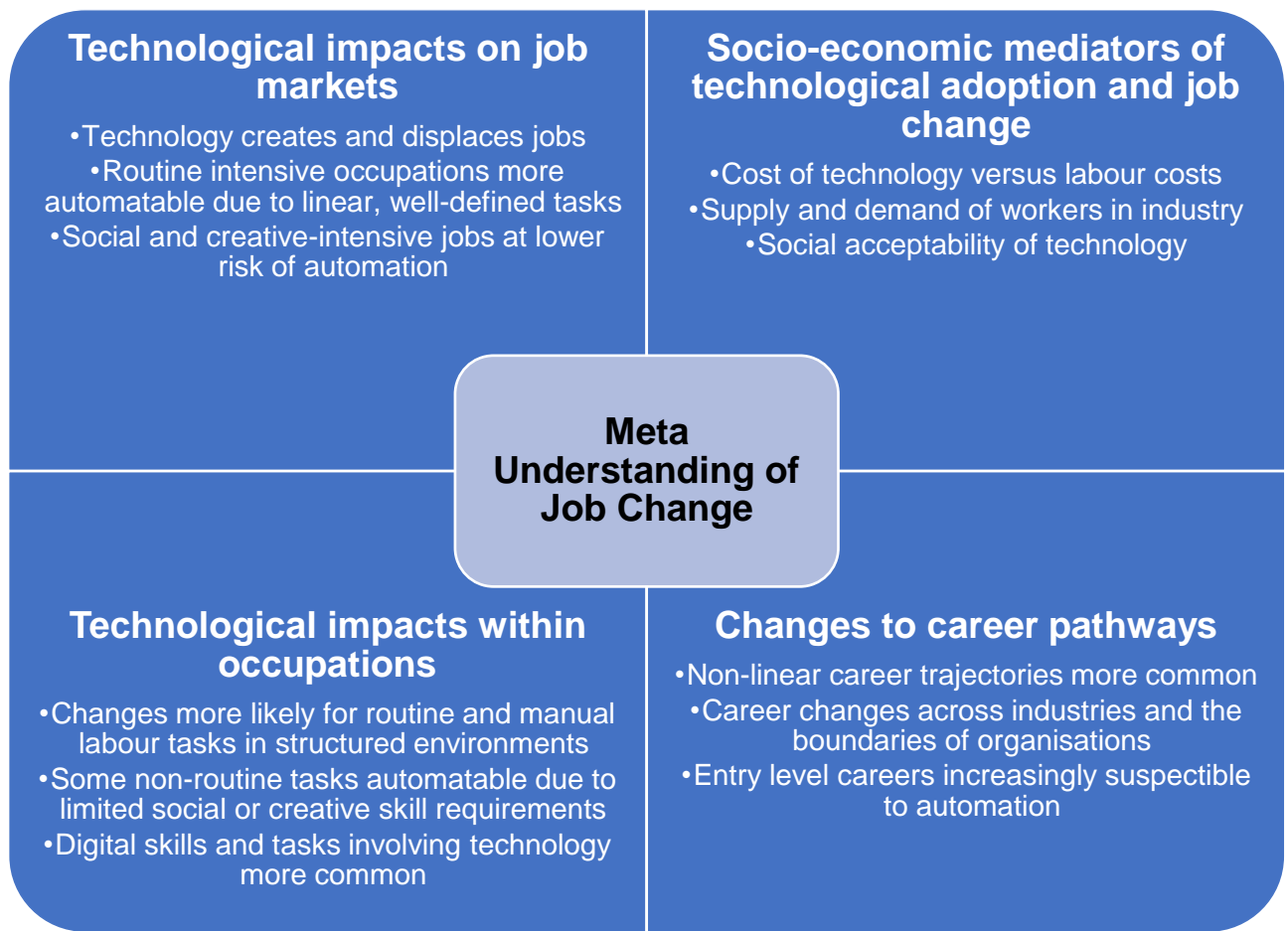


Figure 12 A multi-component framework for a meta understanding of job change

To illustrate the relationship between a meta understanding of job change and other important career constructs and processes, a schematic diagram is presented in Figure 13 below. This schematic does not depict every relevant career construct, but it provides an overview of how a meta understanding of job change involves certain prerequisites and how it can directly or indirectly contribute to people's career goal setting, decision making, and preparedness.

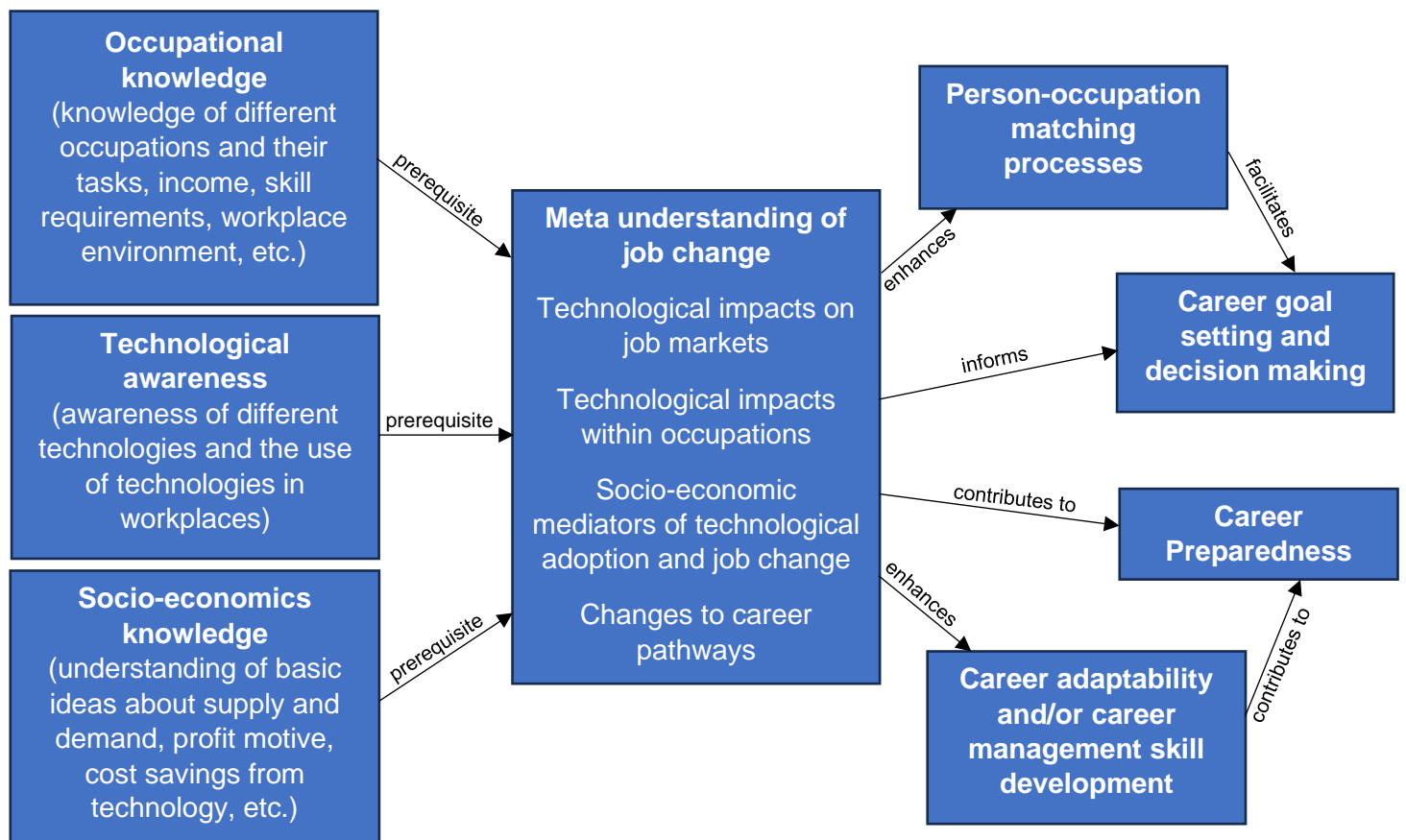


Figure 13 Relationship between a meta understanding of job change and other career constructs

Occupational knowledge, technological awareness, and socio-economics knowledge are specified as prerequisites of this capacity due to the foundational knowledge needed to build a comprehension of how occupations and job markets may change (e.g., a person first needs to learn that occupations consist of multiple tasks). As a child or adult develops their meta understanding of job change, they can engage in more advanced person-occupation comparison or matching processes. Rather than relying on a purely static conception of occupations and job markets, an individual (with/without assistance from practitioners) can feed into the comparison/matching process an understanding of how specific occupations or job opportunities more broadly may change. This can help the person to arrive at a tentative career plan,

goal, or decision which achieves a closer (or longer-term) correspondence between the skills, knowledge, values, and proclivities of the person, and the evolving skill and task requirements of the specific career option(s). Equally, a meta understanding of job change can enhance a person's career adaptability. By investing time and cognitive effort in learning about the reasons and principles underlying automation and job change, it is possible that a person is more likely to become curious, concerned, and confident about their career.

Whilst a meta understanding of job change may aid children and adults in developing their career aspirations, forming career choices, and enhancing their career preparedness, there are several limitations associated with this framework. The first concerns the issue that because impacts of technology on job markets and occupations are not known with a high degree of certainty, some of the principles or heuristics people could learn to deduce future job changes could be somewhat flawed or insufficiently accurate. For example, deducing conclusions about the future automation of low-skilled vis-a-vis medium-skilled occupations remains subject to ongoing debate (Mandelman & Zlate, 2022).

Nevertheless, to make informed career choices and prepare for the uncertainty of future job change, a certain degree of imprecision is likely irrespective of the approach taken. The benefit of heuristics and reasoning principles, such as those described in Figure 12, is that they can provide a good approximation for people's planning and decision making without placing excessive cognitive demands on the individual (Kahneman, 2011). Many of these principles are affirmed by a wide range of researchers (Arntz et al., 2017; Autor, 2015; Frey & Osborne, 2017; PwC, 2018). Nonetheless, people should be made aware of their limitations and be encouraged to

seek out additional sources (i.e., industry insiders or alternate job projections) to verify their conclusions (Lent, 2018).

Another challenge may include the high cognitive demands required from children or adolescents to understand the reasons and factors behind job change. As will be discussed later, this challenge may be overcome to some extent through appropriate content scaffolding techniques. Similar to the way children learn about climate change and sustainability in schools, and despite the uncertainty surrounding future changes to the environment, underlying reasons and general principles are often explored (e.g., greenhouse gas emissions contribute to more extreme weather events on average) and can be taught during primary and secondary education with increasing levels of complexity (Kumar et al., 2023).

In summary, within this section, to further unpack the complexities of supporting children's career aspirations and preparedness, it was revealed how gaps in recent intervention approaches and career education provisions (i.e., limited content on job change principles) merited supplementary approaches. To address the nuanced job changes resulting from automation and to thereby overcome the limitations of person-occupation matching approaches and the promotion of general career skills, a meta understanding of job change was proposed and explained. In the following sections, complexities related to the emotional and cognitive challenges and opportunities of supporting learning about job change are discussed.

6.3.3 Emotional complexities of learning about job change

A further complexity examined in this thesis involved the emotional benefits and challenges of supporting children's learning about job change. Findings from Study Three indicated that the Scottish career education stakeholders viewed support for

children's learning about job change as a source of inspiration to engage children in developing their career preparedness. The basis for this observation was that the novelty and significance of the changes being brought about by technology may stimulate enhanced career exploration and learning among young people than would typically be the case while learning about a static world of work. Promoting children's attention and fostering their motivation are important conditions for promoting their learning (Bandura, 2001). Within the framework of SCCT, this enhanced career learning can aid children's development of improved career knowledge, self-efficacy beliefs, and aspirations for their future careers (Bandura et al., 2001; Lent, 2013b). In this sense the environmental factors of automation and job change can be understood as a potential source of inspiration and a support for children's career preparedness rather than only an actual barrier to their future career attainment (e.g., such as the career risks identified in Study One).

From an alternative perspective, however, it is also important to recognise automation and job change as a potential perceived barrier (Lent & Brown, 2020). To this point, career education stakeholders indicated the emotional challenge and anxiety that some children can experience from learning about uncertainties in future job markets and how technology could displace certain jobs. Similar pessimistic beliefs about automation and future job markets have also been reported in surveys of young people across different country contexts (Speakers for Schools, 2018; WorldSkills & OECD, 2019). Being in anxious emotional states can negatively impact children's learning and self-belief development (Bandura, 2001). Moreover, having negative perceptions of environmental barriers such as restrictive job markets can compromise the career goals children and adolescents set themselves and whether

these goals are effectively translated into choices and attainments (Lent & Brown, 2019; Lent et al., 2000; Lindley, 2005).

To build on children's curiosity to explore the novel changes taking place in the world of work without creating anxiety about possible job displacement, stakeholders can work to build children's sense of agency and awareness of job change. For instance, promoting children's meta understanding of job change and showing children how technology has historically created new jobs, and is likely to continue doing so (Autor, 2015), means that children can build an awareness of the future job possibilities and gain a greater sense of control in securing work in the future. Career interventions and stakeholders can also work with young people to identify their perceived barriers, develop coping strategies, and help them to develop emotional and social supports (e.g., self-efficacy boosting activities or career mentors) to address the perceived and actual barriers they face (Lent, 2013a).

6.3.4 Cognitive complexities of learning about job change

Managing cognitive demands and the complexity of learning about automation and job change were issues raised in studies two and three. Stakeholders interviewed in Study Three explained how it was important to use a scaffolding approach to incrementally introduce children to more difficult career and job change concepts as they grow older. For those in primary school or younger, purposeful play and work realistic learning experiences could reportedly aid children's growing awareness of different occupations, skills, and workplaces associated with the future of work. For more difficult concepts, such as how technology can impact both routine and some non-routine occupational tasks (Frey & Osborne, 2017), it may be necessary for teachers and practitioners to introduce such concepts later in children's development. But the simplified or composite ideas for these concepts could be

introduced at the earlier stages of children's development (e.g., exploring how occupations have different tasks). Despite acknowledging there was a need for enhanced curricular support, teachers and career practitioners indicated there could be opportunities to connect children's learning in different school subjects to emerging career pathways and topics.

6.3.5 Practical complexities of supporting learning about job change

Career education stakeholders also noted various practical challenges. With respect to inviting career role models into schools, it was suggested that with rapid changes in new technologies, sectors, and jobs it was becoming harder for teachers and practitioners to find role models for children who can represent emerging industries. This was particularly difficult for teachers working in more remote areas. SCCT and SCT specify that the influence a role model can have on children's career learning and development depends to some extent on whether they can closely identify with the model and for the model to represent the target career (Bandura, 2001; Lent et al., 2002). To navigate these practical challenges, the use of technology (e.g., virtual career talks or simulated workplaces) may aid teachers and practitioners in providing more authentic and identifiable career learning experiences for children.

Policymakers, practitioners, and teachers themselves affirmed the need for enhanced career education training for pre-service and/or in-service teachers. Because of the rapidly changing nature of the job market, it is important for teachers and other stakeholders to keep abreast of new skill demands and job opportunities to effectively prepare children for their future careers (Kashefpakdel et al., 2018). Increased collaboration between stakeholders and employers could be a means by which teachers, practitioners, and parents can learn of new developments in the world of work and collectively provide a more comprehensive and consistent career

education provision. Stakeholders can also reflect on their own occupations and how they have, and will continue to be, affected by the adoption of new technologies. Insights from these reflections can help teachers and practitioners to create more informed service or school cultures to communicate with children about the evolving career-related opportunities and challenges they may face. In the following section, the complexities of understanding and addressing group factors are discussed.

6.3.6 Complexities of understanding and addressing group factors

The first study in this thesis revealed that various group factors including age, gender, and parental occupation could be statistically significant variables predicting which groups of school students could be more likely to pursue occupations with a greater susceptibility to automation. In the case of age differences, it was found that as children progress beyond the age of 11 a markedly higher proportion are likely to express higher-risk career aspirations. This result was important for clarifying certain complexities. First, the result helps to identify a developmental period (between the ages of 12-14) at which children's automation-related career risks may become distinctly more pronounced. This suggests that career aspiration interventions may benefit from starting in pre-adolescence to equip children with relevant capacities and information to develop career goals or limit their circumscription of career options which could be realistic opportunities in future job markets. Some scholars have previously argued that conducting interventions prior to adolescence may help to influence or support children's career aspirations before they become more stable and less amenable to change in adolescence (Archer, DeWitt, & Dillon, 2014).

Findings from the second study showed however that recent career aspiration intervention studies have focused more on adolescents when compared with pre-adolescent children (although the number has grown over the last decade). An

advantage of focusing on adolescents could be that because teenagers are closer to key educational and career decision-making points (Piesch et al., 2020), enhanced career aspirational support at this developmental stage may be more likely to translate into informed career choices because the recently acquired information is more readily retrievable from memory (Kahneman, 2011). In contrast, without disregarding the benefit of supporting adolescents' career aspirations and preparedness, findings from Study Three indicated that career education stakeholders affirmed the advantage of supporting children from an earlier age in primary school or even pre-school. Citing younger children's greater openness to explore diverse career options, stakeholders understood pre-adolescence as a suitable starting point for children to begin learning about job change, develop career management skills and adaptability resources, and expand their career options for an increasingly shifting job market.

Though the three studies in this thesis did not experimentally verify the relative impact of earlier interventions with children, the findings nonetheless contribute to a growing understanding of the potential value of early interventions, particularly in light on the emerging career risks associated with job automation. Interpretations of the results from Study One can potentially inform approaches for future career aspiration interventions with younger children and adolescents. More specifically, while the reason for the observed risk increase in early adolescence can partly attributed to children's expanding knowledge of more Realistic and Conventional occupations, it may more significantly be due to adolescence's orientation toward a unique self-concept when forming their career aspirations at around age 14 (Gottfredson, 2002; Helwig, 2001). Since there could be benefits in encouraging children to explore and consider new occupations created by technology (rather than

various pre-existing occupations which might be subject to automation), there could be possibilities for career interventions to utilise this psychological mechanism of self-differentiation to encourage children to explore and self-identify with a new and unique career within an emerging sector.

Gender risk differences were another important group finding from Study One. A larger proportion of male students were found to express higher risk aspirations than female students. A primary reason for this risk difference was due to a greater average proclivity among young boys to aspire to manual labour-intensive occupations (Chambers et al., 2018; Stoet & Geary, 2018). Compared to social-intensive roles, which female students expressed aspirations for frequently, manual labour-intensive occupations are thought to be more susceptible to automation over the coming decades (Frey & Osborne, 2017). Moreover, because female students are presently achieving higher educational attainment and expressing higher status career aspirations on average than their male counterparts (Howard et al., 2011; OECD, 2015; Parker et al., 2018), there could be a greater proportion of female students aspiring to higher status/wage occupations. These roles are similarly predicted to be less susceptible to automation (Manyika et al., 2017; OECD, 2018).

Despite the possible gender risk differences identified in Study One, findings from Study Two indicated that recent career aspiration interventions have targeted girls more frequently. Intervention studies focused exclusively on boys were not found. Female-focused interventions were often based on the objective of reducing the disparity between girls' and boys' attainment of STEM careers (González-Pérez et al., 2020). Stakeholders interviewed in Study Three similarly emphasised the importance of addressing this gender gap. Supporting more girls to explore and aspire to STEM careers continues to be a reasonable approach partly due to the

predicted growth of digital/STEM occupations and skills (World Economic Forum, 2020). Enhanced alignments between young females' career aspirations and future job markets could help to reduce existing career-related inequalities. Equally, findings from the three studies indicate that the emerging career risks impacting boys could also benefit from enhanced attention. Rather than dissuading young males from high-risk occupations, there is scope for career aspiration or preparedness interventions to encourage boys to explore the changing requirements within these occupations, and to build supports or coping strategies (e.g., seeking out industry experts) to navigate possible automation-related barriers (Lent, 2018).

Different socio-economic groups could also encounter new career risks while pursuing and preparing for their future careers. Although the results from Study One involving primary school children were not statistically significant to securely conclude that lower socio-economic groups will pursue careers at higher risk of automation, separate research with secondary school students has found evidence that affirms this conclusion (Mann et al., 2020). This is due to the greater likelihood of low-wage and low-skilled roles being subject to automation. In some accord with this result, findings from studies two and three indicated a significant focus on supporting lower-income children to help them aspire to and secure higher wage employment. However, supporting children from more disadvantaged backgrounds may not be straightforwardly simplified to raising their aspirations. As some high status/wage roles are also potentially susceptible to automation along with many low-wage occupations (Frey & Osborne, 2017), it is important for career interventions and career education stakeholders to more systematically address the diverse influences of accelerating automation with lower-income groups.

An additional group complexity examined in this thesis concerned the influence of parents on children's career aspirations and preparedness. Scottish career stakeholders in the third study affirmed the influential role parents can play in children's career pursuits, as well as the value of involving parents in developing children's career preparedness. However, a unique insight identified from Study One was the possibility that school students with career aspirations matching their parent's occupation were more likely than students without this match to express a higher risk career aspiration. This finding points to a potentially important variance in the influence of parents on children's career aspirations and preparedness that career education stakeholders could be alert to. When partnering with parents to support children's career development, stakeholders could, in some cases, unintentionally enable children with parents holding high-risk occupations to consider or pursue similarly high-risk careers as their parent(s).

It is possible that parents value as a career role model for their children may therefore involve certain limitations, particularly as new occupations emerge from ongoing technological developments. Partnerships between parents, career practitioners, and/or teachers can benefit from a common understanding of the challenges and opportunities raised by automation and job change. Parents, as role models and experts in their field, can share relevant insights on the technological changes underway in their field and help their child to build supports or coping strategies. Career practitioners and teachers could also encourage a diversification of career role models (e.g., invited industry experts or social media influencers) to help children consider a broader range of career options and acquire supports to more easily transition into fields which are not well represented in the home environment.

Taking account of these above-mentioned group differences could be important for career education stakeholders when supporting children's career aspirations and preparedness for a rapidly changing world of work. Yet, the career policymakers, practitioners, and teachers interviewed in Study Three conceptualised automation as having a universal impact on groups rather than a differential effect. Therefore, informed by the results from Study One, there could be a benefit in raising awareness among various career policymakers and practitioners regarding how automation could impact groups differently. Commonly used approaches to support groups, such as generically raising the aspirations of low-income groups or involving parents without considering their occupational influences, may not sufficiently address the career risks associated with accelerating automation. Instead, a more evidence-informed and tailored approach is likely needed; one that recognises the evolving intersection of career risks impacting specific groups and subgroups. This approach should not, however, neglect the unique individual-level challenges any given young person faces when aspiring to and preparing for their future careers (e.g., new skill requirements in lower-risk or higher-risk occupations).

From this synthesis of research findings, various complexities of supporting children's career aspirations and preparedness for automation and job change have been revealed. These complexities refer to the limitations of and supplements to person-occupation matching approaches, including the promoting of a meta understanding of job change. Additionally, emotional, cognitive, and practical complexities of supporting children's learning about the changing world of work have been discussed, along with the complexities of supporting different groups of young people. Drawing on these insights, the next section outlines relevant contributions to the development of SCCT.

6.4 Contributions to the development of SCCT

SCCT specifies that personal variables such as age, gender, and ethnicity, along with environmental factors, can shape the career aspirations and eventual choices young people make (Lent, 2013b; Lent & Brown, 2019). Consistent with this prediction, results from Study One indicated statistically significant differences in school students' career aspirations and associated job automation risks across age, gender, ethnicity, and parental occupation categories. In the case of socio-economic groupings, small proportional differences were measured between lower socioeconomic students and higher socioeconomic students. These differences were not however found to be statistically significant at the primary school level. Broadly speaking, the results from Study One corroborated the prediction of SCCT that personal variables and background environmental factors contribute to the career aspirations children and adolescents form; and as a consequence, certain environmental barriers they may encounter (e.g., unavailable occupations in the job market).

There was nonetheless a distinctive group finding from Study One that, within the scope of SCCT constructs, may lack sufficient explanatory power for evaluating children's career pursuits and future automation-related risks. SCCT does not explicitly provide a prediction as to when age-related factors may become more pronounced. Instead, SCCT suggests age influences children's learning experiences which over time shape their self-efficacy beliefs and outcome expectations. These beliefs in turn determine their career interests and aspirations. However, the marked shift in school students' career aspirations and automation-related career risks measured between the ages of 11-13 in Study One (aspirational risk increase from 7% to 20%) cannot be straightforwardly attributed to incremental changes in SCCT

constructs. Alternatively, as specified in the Theory of Career Circumscription and Compromise, children's orientation towards a unique self around the age of 14 may provide a superior explanation for this distinctive aspirational shift (Gottfredson, 2002; Helwig, 2001).

Because school students' career aspirations were found to be less concentrated around specific occupations/sectors between the ages of 11-13 rather than significantly widening during this period, it is plausible that students' predisposition to self-differentiate at this age point may lead some to identify with careers which are less extensively subscribed to but remain within their known range of career options. While the notion of self-concept is implicitly contained within the construct of self-efficacy beliefs (Lent et al., 2002), to understand and address the automation-related career risks children may encounter, it could be important for researchers and practitioners to explicitly attend to this developmental mechanism. Researchers and practitioners may, for instance, facilitate young people's exploration of the emerging careers and novel opportunities resulting from automation by utilising their orientation toward a unique self; encouraging them build a unique career identity within the changing world of work.

According to SCCT, actual and perceived environmental barriers, such as those relating to changing job markets, can reduce the likelihood of young people's career aspirations translating into corresponding career choices and attainments (Lindley, 2005). As previously discussed, the analysis conducted in Study One indicated that a moderate minority of young people may pursue jobs at risk of automation and may consequently encounter actual environment barriers (i.e., reduced employment opportunities). Additional findings from Study Three also indicate that children may experience perceived barriers as well. Insights from career education stakeholders

suggest that there may be some children and young people who hold some degree of anxiety about job change and possibly perceive related barriers in attaining their future careers. This finding is consistent with recent national and cross-national survey results reporting that a large proportion of young people believe it will be difficult to attain a career in the future due to increasing automation (Speakers for Schools, 2018; WorldSkills & OECD, 2019).

However, stakeholders also observed that perceiving or learning about automation and job change may equally function as a source of inspiration for children's career preparedness. This possibility was attributed to the novelty and intrigue created by the introduction of new technologies in workplaces. A unique contribution of this research to SCCT was therefore to reveal how the environmental factor of automation and changing job markets might function as both a perceived support or source of motivation, as well as an actual and a perceived barrier. Indeed, because of the accelerating nature of job change, such perceived and actual environmental barriers/supports could become increasingly important factors influencing the development and translation of young people's career aspirations into career choices and attainments. Further empirical research, particularly involving children themselves, would help to further clarify the specific barriers and/or supports young people perceive in relation to automation and job change. Such research could also examine the extent to which these perceptions are held, and how they may impact young people's subsequent career goals and choices.

Whilst SCCT outlines the influence of environmental barriers such as job markets, along with supports to help people prepare for possible career change (Lent & Brown, 2019, 2020), the theory does not specify the important contribution of learning the reasons and principles underlying automation and job change for

people's career preparedness. As previously discussed, a meta understanding of job change could therefore add to (or potentially integrate within) theories such as SCCT by promoting various heuristics or principles by which ongoing changes within occupations and job markets can be more effectively discerned and prepared for. This can also help to overcome some of the limitations of the person-occupation matching processes which are embedded in SCCT.

Another finding relevant to SCCT concerns the ongoing predictive value of young people's career aspirations. Barring an overriding influence from environmental barriers or a lack of environmental supports, SCCT predicts that people's career aspirations will align with their future career choices and attainments (Lent, 2013a; Lindley, 2005). However, as revealed in Study One, there are potentially a moderate proportion of young people (approximately 25% of 17–18-year-olds) expressing career aspirations that align with occupations which could be highly susceptible to automation over the coming decades. Should some or all of these jobs be replaced by machines, it is likely that the predictive power of career aspirations may reduce as young people's expressed career aspirations would not translate into corresponding career choices and attainments in adulthood. Given this possibility, there is reason for new longitudinal research to investigate the reliability of young people's career aspirations to predict their future career attainments. This is an important area of future enquiry given that the most recent longitudinal studies investigating this question have involved student cohorts from several decades in the past (Schoon, 2001; Schoon & Polek, 2011).

6.5 Recommendations for future research

As several lines of enquiry have been undertaken in this thesis, future research can build on and advance several insights detailed herein. To start, the model of job

automation used in Study One was useful for estimating the types of jobs more likely to be subject to automation over the coming decades (Fuei, 2017) and to thereby investigate automation-related career risks across groups of school students. However, very recent developments in AI-based technologies, including ChatGPT, GitHub Copilot, and DALL-E, have prompted some to speculate about whether a new range of industries, including some creative industries, could be partially or extensively impacted by new generative AI technologies (Chui et al., 2022). Because the model used in this research was based on the assumption that creative skills and occupations are generally less likely to be subject to automation over the coming decades (Frey & Osborne, 2017), future research using more up-to-date job automation models could be merited to better estimate the career risks and opportunities children may encounter.

There are also opportunities for future researchers to advance the results from Study One and to clarify potential group differences with enhanced precision (e.g., using panel data). Career researchers, as well as researchers in psychology, can further test and disentangle these developmental and psychosocial factors, including examining the interaction effects between group variables (e.g., risks for low-income females). Disentangling these group factors with greater precision can help policymakers and practitioners in developing more targeted and tailored content to aid the career development of different subgroups.

Another area for future research could involve conducting intervention studies (possibly with experimental designs) to study the impact of job change learning on young people's career aspirations. While previous research has indicated a positive correlation between occupational knowledge and children's career aspirations (Rohlfing et al., 2012; Schmitt-Wilson & Welsh, 2012), a new line of research is

needed to empirically investigate how learning about the changing availability and characteristics of jobs may impact children's career aspirations, as well as related constructs such as self-efficacy beliefs and outcome expectations. Additionally, a new career construct of a meta understanding of job change was proposed in this research. To critically examine and advance the development of this construct, it would be important for future theoretical research to clarify its constituent elements, conceptual scope, and implications for people's career decision making and preparedness. Empirical research could also investigate how children and adults may effectively develop this capacity and to examine its utility for helping people solve career problems, set career goals, make more informed career decisions, and contribute to career preparedness.

Finally, another future direction for research may involve exploring children's first-person perspective on how they think and feel about automation and job change learning. In this thesis the perspectives of policymakers, career practitioners, and teachers were collated and several possible insights relevant to children's learning about job change were specified (e.g., possible anxiety and motivation for novelty). However, it could be beneficial to explore children's personal viewpoints while learning about automation and job change to better understand the differing emotional and cognitive factors which may inhibit or enable their career learning and preparedness. This would address a gap in the existing body of literature as most prior research has focused on adolescents' general attitudes towards automation (Speakers for Schools, 2018; WorldSkills & OECD, 2019). Carrying out such research with children can affirm their rights to participate and contribute to improving their educational experiences and future opportunities.

6.6 Implications

Based on the insights gained from investigating the complexities of supporting children's career aspirations and preparedness for automation and job change, there are important implications for policymakers, career practitioners, schools and teachers, parents, and children. Before specifying these implications in the next section, it is important to reiterate that due to the uncertainty in predicting the exact consequences of future job automation, there is likely to be some margin for error in proposing specific implications for different stakeholders. Nonetheless, given the potential career risks associated with taking no action, or using existing approaches which may not sufficiently address job change or the nuanced challenges of accelerating job automation, there is sufficient reason to consider new and evidence-informed implications for policy and practice.

6.6.1 Policymakers

The findings discussed in this thesis include several implications for policymakers. Presently, there exist discrepancies between the career aspirations school students hold and the existing supply of jobs (Hoff et al., 2022; Rogers et al., 2020). Looking ahead to the future, as revealed in the results from Study One, there is a possibility that a sizeable proportion of young people, and certain groups in particular, may aspire to occupations at risk of automation over the coming decades. This could result in some young people experiencing unemployment or various opportunity costs. Early experiences of unemployment can be detrimental for young people's long-term earnings and career satisfaction (Möller & Umkehrer, 2015; Mroz & Savage, 2006). Such findings raise the question of whether there is a growing imperative for governments and policymakers to address mismatches between young people's career preferences and future job supplies. In this regard there are

possible benefits for governments and people, but drawbacks are also plausible.

Governments and policymakers may address career aspiration-job supply discrepancies for the purpose of minimising labour shortages or skill gaps in certain occupations or sectors (Hoff et al., 2022).

However, from another perspective, preserving individuals' freedom of career choice is important. So too is the economic challenge of creating more desirable jobs which better align with people's personal interests or proclivities. None of these options are likely to be straightforwardly achieved or without various trade-offs. Whether aspiration-job supply mismatches are addressed for the benefit of the economy and/or to enable more people to pursue their intrinsic career passions, caution should be taken when attempting to shift people from higher-risk careers to lower-risk occupations. This is because policy or programmes based on predictions about automation or future job markets, by operating on false assumptions, could unintentionally redirect people away from roles in which they may have otherwise succeeded (Lent, 2018) and which remain important for the economy. Nevertheless, because of the accelerating impact of job automation, there is a present opportunity for government officials and the public at large to engage in extended discussions on whether and how best to resolve aspiration-job supply discrepancies to minimise labour shortages and/or enable more people to find careers that they find intrinsically interesting or personally fulfilling.

From a Scottish government perspective, it was revealed that Scottish career policymakers and documents conceptualised job automation as creating new occupations rather than resulting in the mass displacement of workers. Concurrently, policymakers understood that technology may impact certain types of jobs more than others, but also that there is considerable uncertainty in predicting future automation.

Juxtaposing a positive framing of the job creation consequences of automation with a cautious and nuanced account of job change may carry the risk of contributing to misinterpretations. This is because the contrasting messages may create doubt in practitioners' or young people's minds about whether a given occupation is likely to be readily attainable in the future, or whether, due to its task makeup, it is likely to be at high risk of automation. While emphasis on the positive consequences of automation could be beneficial for promoting high outcome expectations and self-efficacy beliefs, it is important for career education policy to specify the distinct features of future automation in a comprehensible language. This can also include making clear distinctions between short-term and longer-term job trends.

Whilst discussing differences across groups, Scottish policymakers and career education documents specified that automation would produce universal rather than differential impacts across groups. Yet, the results from Study One suggest that there could be automation-related career risk differences across various groups. Consequently, there could be an opportunity to raise awareness among career policymakers of the emerging career risk differences across groups of children as they aspire to and prepare for their future careers over the coming decades. Making clear distinctions between the differing group impacts of automation in career education policy can aid practitioners in judiciously weighing up the advantages and possible drawbacks of addressing job change with different groups. It is important that such policies and initiatives are not designed to dissuade groups of children from sectors or occupations predicted to be at high risk of automation due to the uncertainty associated with such predictions (Lent, 2018). Rather, this career support could entail helping children from different groups to discover new roles in their

preferred industries and/or to develop barrier coping strategies and supports to prepare for the new requirements in their preferred occupations (Lent, 2018).

Key insights from studies 2 and 3 indicated that recent career aspiration interventions, as well as career education policy within the Scottish context, have mainly emphasised the acquisition of general career skills (e.g., career management skills and meta skills) and learning occupational information or skills. This policy and intervention focus may, as previously discussed, include some limitations and overlook the benefits of helping children understand the reasons and principles underlying automation and job change. In formulating career and educational policy for a rapidly changing world of work, there is reason to include provisions in support of children's meta understanding of job change. While additional training may also be needed to help career practitioners and schoolteachers effectively deliver this content on automation and job change principles, it could ultimately help young people to engage more critically in their future career planning and discover reasons to learn new skills relevant to their futures.

Supporting the career preparedness of young people in more remote areas or low-income communities may particularly require enhanced attention from policymakers. Scottish career policymakers and practitioners interviewed in Study Three explained how those in more deprived or remote areas of the country can experience reduced access to emerging technologies, receive fewer opportunities to learn with these technologies, and may therefore have less opportunity to explore their implications and applications in workplaces. Moreover, inviting career role models to represent emerging industries might be becoming more difficult according to teachers and practitioners working in remote areas. To respond to these challenges, policymakers could consider increasing financial investments in the career education of children

and young people in more remote or low-income areas. Supporting schools and career services to establish partnerships with employers in new or growing industries and developing technological solutions (e.g., using virtual reality technologies) may aid teachers and practitioners working with children in remote areas.

6.6.2 Career practitioners

Of import to both career policymakers and practitioners, findings from the three studies highlight several reasons why engaging children in learning about careers and job change from primary school (and possibly earlier) could be beneficial.

Results from Study One suggest that as children enter adolescence, they may become distinctively more likely to adopt career aspirations which are associated with a higher risk of automation. Recognising potential benefits in supporting preadolescent children in their career learning, insights from Scottish policymakers and practitioners reported in Study Three indicated that this early career learning may help to widen children's career options for rapidly shifting job markets and take advantage of younger children's openness to new career experiences to explore emerging opportunities in the world of work. Yet, despite the possible benefits, recent career aspiration interventions identified in Study Two focused less frequently on pre-adolescent children.

To enhance children's career preparedness for automation and job change it could be beneficial for career policymakers and practitioners to consider extending career provisions to those in the early primary school years (and possibly younger). By doing so children might be more able to develop a broader range of career options, including for growing sectors such as STEM (Archer, DeWitt, & Dillon, 2014). Earlier interventions or provisions may facilitate a greater awareness among children of the changing job opportunities and occupational requirements prior to adolescence – a

developmental period where children's career aspirations may become more stable (Helwig, 2001) and higher-risk (Sowa et al., 2022).

In supporting younger children's education and preparedness for job change it may nonetheless be important for career practitioners to be aware of certain challenges. Teachers and career practitioners interviewed in Study Three explained that concepts relating to careers and job change may need to be scaffolded due to their complexity. Practitioners may therefore support younger children by first introducing career topics, covering different occupations (including occupations in Conventional or Realistic fields) and exploring job characteristics which many can lack sufficient knowledge of (Ferrari et al., 2015; Schmitt-Wilson & Welsh, 2012). Practitioners and educators could connect children's play and learning with digital toys or devices to different industries to help them build conceptual links between technology and jobs. For instance, a child while playing with a robot digger or programming a toy could be encouraged to explore how machines can perform various work-related tasks. Gradually as children progress into later primary school or secondary school, practitioners and educators may build on this initial understanding to explain how occupations can contain multiple tasks, including routine and non-routine tasks, and how these tasks and skill requirements could be differentially impacted as technology advances.

In practice, as with teaching about the topic of climate change, practitioners should be careful not to present the principles associated with job change as definitive ways to predict the future of occupations and job markets. Rather, there can be opportunities for children and practitioners to also reflect on these principles critically. This may include seeking out insights from industry experts (or other sources) to

question or verify how technology is shaping job opportunities and skill requirements in different industries (Lent, 2018).

Findings from Study Three revealed that stakeholders identified learning about job change as a potential source of inspiration for children's career preparedness. Children's motivation and self-efficacy beliefs can play an important role in the development of their career aspirations, learning, and development (Bandura et al., 2001; Lent & Brown, 2019). To spark children's interest in their career preparedness there may be reason for practitioners and educators to emphasise the novelty and significance of the technological and occupational changes underway, along with the new job opportunities being created. This may include, for example, exploring how new technologies using artificial intelligence (e.g., ChatGPT, DALL-E) can be used to complete occupational tasks such as writing a policy brief or creating code for website design.

Due to the prospect of job loss and uncertainty in future job change, career education stakeholders additionally suggested that some children may experience career anxiety. This has also been highlighted in recent cross-national research with young people (Speakers for Schools, 2018; WorldSkills & OECD, 2019). Aided by ongoing research into the specific sources of children's career anxiety, career practitioners and educators can be more alert to the psychological challenges children face. Relevant coping strategies and emotional and social supports (e.g., career mentors) can be used to prepare young people for the perceived and actual challenges associated with automation and job change (Lent & Brown, 2020).

6.6.3 Schools and teachers

Systems of mass schooling have been closely tied to the world of work for over a century, with school curricula and purposes, to a lesser or greater extent, often focused on preparing students to get and hold jobs (Kliebard, 1999; Ramirez & Boli, 1987). Considering the ongoing changes within occupations and job markets and the results discussed in this thesis, there are important implications for school systems and teachers. Similar to the person-occupation matching process in the domain of careers, schoolteachers are, alongside other aims (e.g., promoting student wellbeing and social cohesion), expected to teach children skills, knowledge, and dispositions that correspond to demands in the world of work (Education Scotland, 2004; OECD, 2019). Yet, because of rapid changes in job markets, occupations, and skill demands, assumptions about current school subjects and learning priorities may need to be revisited. For instance, new developments in artificial intelligence may mean that subjects such as computer coding could be of lower priority as machine learning technologies such as ChatGPT exhibit advanced competencies in this area (Chui et al., 2022).

Various subjects (e.g., robotics) and pedagogical approaches (e.g., problem-based learning, personalised digital tutors) have been proposed as possible responses to help school students develop skills and knowledge for the changing world of work (Doucet et al., 2018; OECD, 2019; Penprase, 2018). These proposals are generally based on the idea that schools and teachers should foster the distinctly human capacities that machines will not easily replicate. Capacities such as creativity, social competencies, or other domain-general skills (e.g., metacognition, critical thinking, and problem-solving) (Doucet et al., 2018). In the first study it was revealed that primary and secondary school students primarily expressed aspirations for lower-risk

careers in social- and creative-intensive occupations. Building on school students' dispositions for these career types, schools and teachers may support students to explore how creative, digital, and social skills/tasks could become an increasingly prominent part of different occupations (World Economic Forum, 2020). This may encourage students to think and plan for their future careers more intentionally, giving more impetus and direction to their educational endeavours. This may in turn motivate students to develop these emerging skills in school to prepare for their future working lives.

As shown in this research, in some cases the career aspirations school students develop could align with occupations which may be highly susceptible to automation, such as more routine cognitive and manual labour roles (Frey & Osborne, 2017). Without dissuading students from these roles, educators can foster students' curiosity to explore how these occupational skills, tasks, and roles may change due to the increasing adoption of new technologies in workplaces. There are also opportunities for teachers to build students' career adaptability resources to manage career uncertainty, build resiliency, and navigate the possibility of multiple career transitions (Ginevra & Nota, 2018). Facilitating the development of career supports (e.g., building career networks or mentors from emerging industries) can enable students to comprehend and prepare for ongoing changes in their preferred industries (Lent & Brown, 2020).

Teachers, career practitioners, and policymakers interviewed in Study Three explained how there could be greater integration of careers content across the school curriculum. Because skill/task requirements traditionally associated with certain industries are becoming more prominent in disparate industries (e.g., social skills as a pilot, IT technician, mechanic) (Colombo et al., 2019; World Economic

Forum, 2020), it is important for teachers from different subjects to collaboratively plan across subject boundaries and be given appropriate curricular support to aid students' in their career preparedness (Hughes & Kashefpakdel, 2019). Specialised agencies (e.g., Skills Development Scotland, Developing the Young Workforce Regional Groups) can aid schools in developing age-appropriate activities and content to help children learn about job change and build partnerships with relevant employers.

Teachers and policymakers involved in Study Three also reported the need for enhanced teacher training on careers. Such training for in-service and pre-service teachers could be valuable in building their awareness of ongoing job changes and how to connect subject learning to the evolving workplace demands (Kashefpakdel et al., 2018, 2019). Teachers could also become aware of how teaching itself has been talked about as an occupation which could be partially or substantially automated (Knox et al., 2019) and to critically discuss these ideas with students to stimulate their career thinking.

6.6.4 Parents

Parents can contribute to the career aspirations and development of children through emphasising education, along with sharing values, knowledge, and attitudes towards careers (Liu et al., 2015). A unique insight from Study One indicated that school students expressing a career aspiration which matched their parent's occupation were found to be more likely than students without this match to express a higher risk career aspiration. This finding highlights the possible differential influence of parents holding high-risk occupations could have on the career aspirations and preparedness of their children. Yet, while career documents, policymakers, and practitioners involved in Study Three explained the role and importance of

collaborating with parents in children's career education, they did not recognise that parents holding higher-risk occupations may exert a differential influence. By partnering with these parents, career education stakeholders may unintentionally reinforce career knowledge, skills, and goals that could be affected by automation.

While the involvement of parents in their child's career development ought to remain an important part of or supplement to formal career provisions, due to the emerging risks of automation and creation of new occupations, it could be beneficial for stakeholders to facilitate a diversification of career role models. This could allow more young people, particularly those from families holding high-risk careers, to explore new career possibilities and develop automation-proof skills not commonly modelled in the home environment. Because parents have insider knowledge of their industry/occupation, as well as how technology is changing the occupational skill and task requirements in their occupation, parents can also be supported to leverage their personal experiences to encourage their child to critically reflect on emerging opportunities in the industry and how they can stand out as a potential future candidate. Parents can also aid children in building career supports and barrier coping strategies to prepare for their future careers and navigate possible job transitions (Lent, 2013a).

6.6.5 Children and adolescents

This thesis has revealed that a moderate proportion of children in primary and secondary school could develop career aspirations which align with occupations that are increasingly susceptible to automation. Because these career risks or opportunity costs are potentially of significant consequence, such as unemployment in some cases, financial costs, or skill gaps, it is valuable for children to critically engage with the implications of automation for their future careers and life

preparedness more broadly. However, children who hold higher risk aspirations should not necessarily give up on pursuing careers in these fields due to the socio-economic uncertainties and variable speed of technological adoption across different industries. Rather, the ongoing impacts of technology provide a valuable learning opportunity for all young people, irrespective of their particular aspirations, to explore emerging job opportunities and how their preferred occupations are changing, including the new skills and supports they can develop to thrive in their future career (Lent, 2018). As suggested by stakeholders in Study Three, exploring automation and job change may help to spark children's curiosity and inspiration to prepare for their future careers and overcome perceived and actual career barriers.

Another implication of this research refers to the promotion of a certain mode of thinking about careers, technology, and self. Instead of understanding jobs and technology as strictly separate or static entities which someone merely obtains or occasionally interacts with, children can come to appreciate careers as embedded in a dynamic process of co-evolution with technology. This mode of thinking recognises that as technology evolves it can change the makeup of occupations and job markets, and vice versa. While at the same time these factors can also shape people's self-conception and their career or life trajectory. Though technology and economic trends have been reported by some young people as factors which are relevant to their career decision making (Mbilini et al., 2019; McDevitt et al., 2013), it is important for young people to build on this awareness with a more integrated understanding of the interdependent relationship between careers, technology, economic factors, skills, and personal development.

6.7 Thesis limitations

In this section limitations pertaining to the overall research project are discussed.

Limitations particular to each of the three studies will not be repeated here to avoid repetition. Please instead refer to sections 3.9, 4.10, and 5.8 for the study-specific limitations. First, as this research set out to explore the automation-related career risks children may encounter and potential insights and gaps in existing intervention approaches, it did not attempt to experimentally verify the impact of interventions on children's career aspirations and preparedness. While not claiming to offer definitive solutions, some of the intervention approach recommendations detailed in this thesis may nonetheless benefit from future empirical investigations to examine their effectiveness or suitability for preparing children for the future world of work.

Secondly, results from Study One referred exclusively to career risks linked to future job automation. There are nonetheless other relevant career risks which could not be quantified in this research, but which are important to assess to gain a broader understanding of the range and scale of the career risks and opportunities children may encounter. For instance, the number of career transitions contemporary youth may experience in the future. At present, little is known about whether the average number of career transitions children will experience in the coming decades will increase or decrease and how it may vary across industries and countries. For this reason, it was not possible to reliably estimate such risks in this thesis; nor was it possible to conduct a multiple year/decade long longitudinal study within the timespan of this research.

Other limitations of this thesis concern the geographic scope and generalisability of the findings. Results from Study One pertain to the UK and those from Study Three to Scotland more specifically. Although findings from the systemic review involved a

range of low-, middle-, and high-income countries, most included intervention studies were conducted in the United States, the UK, and Australia. This was due to the requirement for included studies to be published in the English language.

Consequently, it is important to note that not only can intervention approaches and career education provisions with children vary considerably across different contexts, the speed and impact of future job automation will likely vary considerably across countries as well (Manyika et al., 2017; PwC, 2018). Generalising findings from each study and the thesis as a whole to other country contexts should therefore be approached cautiously (particularly beyond English speaking or higher-income countries). Nevertheless, because technology-related changes to occupations and job markets are likely to occur in some form and scale irrespective of the country context, there remain potentially relevant theoretical and practical findings which may be applicable across diverse country contexts (e.g., supplements to person-occupation matching approaches).

Children's career aspirations and development can be influenced by multiple factors and people. This thesis explored several of these factors (e.g., gender, social class, age, career education provisions). There are nonetheless other important factors which could not be directly investigated in this thesis. Children's friendship group, social media, TV, and other entertainment media are often reported as factors contributing to the development of children's career aspirations and preparedness (Archer, Dewitt, & Wong, 2014; Chambers et al., 2018). Due to the extended time and workload demands that would be involved in obtaining data on these factors in addition to other variables, a trade-off was made to focus primarily on the factors which have, for the most part, been most extensively researched (Schuette et al.,

2012; Wahl & Blackhurst, 2000) and which could therefore be elaborated on in greater detail in this thesis.

Practical issues (i.e., time limitations and Covid-19 restrictions) were also reasons why parents' and children's perspectives could not be directly studied in this thesis. Yet, through obtaining rich descriptions from other career education stakeholders who have worked closely with parents and children (i.e., policymakers, teachers, and career practitioners), various issues pertaining to parental support and children's career learning experiences could be illuminated to some extent. There remains ground for future research to explore the perspectives of children and other stakeholders, as well as the additional factors which may contribute to children's career aspirations and preparedness for automation and job change.

6.8 Conclusion

Developing an informed career aspiration and preparing for a career is becoming an increasingly complex activity for children and adolescents. Accelerating changes in technology and the world of work present children with an evolving set of career options and changing occupational task and skill requirements. To investigate the complexities of supporting children's career aspirations and preparedness for the changing world of work, three interconnected studies were carried out following a mixed methods design. The first study estimated automation-related career risk differences across groups of school students. Results from the study revealed that adolescents, male students, and those with parents holding a high-risk occupation could be more likely to express a higher risk career aspiration.

Building on the results from Study One, the second study critically examined recent approaches used in career aspiration intervention studies. This was done to gain

insights and identify gaps in how these intervention approaches have/have not addressed the changing conditions underlying careers. It was shown that recent interventions have focused on select demographic groups. But the intervention objectives and content largely did not address changes within occupations or job markets.

Subsequently, the final study set out to explore the conceptual and practical challenges and opportunities of supporting children's preparedness for automation and job change. To achieve this a case study was conducted of the Scottish career education system. Findings indicated that the career education stakeholders framed automation as resulting in job creation rather than the mass displacement of jobs. This conception was juxtaposed with the understanding that certain occupational types could be more susceptible to automation than others. However, despite also recognising average differences in the occupations various groups of children tend to pursue, policymakers and practitioners did not anticipate differential impacts across groups of children. While specifying several possible emotional and cognitive challenges of learning about job change, these topics were also viewed as an opportunity to motivate and expand children's career horizons.

In bringing this collection of findings together, this thesis has contributed to the development of career theory and practice. It has produced insights for career policymakers, practitioners, and teachers. This research has revealed new evidence to elucidate why person-occupation matching approaches may encounter more difficulties over the coming decades but may nonetheless retain some utility. A meta understanding of job change was proposed as a supplementary capability by which young people can make informed inferences about the likely impacts of technology on job opportunities and occupational skill requirements. Finally, by elaborating on

the concept of environmental barriers and supports specified within SCCT, this thesis has illustrated how automation and job change could function as both an environmental barrier and a source of inspiration for promoting children's preparedness for the future world of work.

7.0 References

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Appendix A: Research Ethical Approval



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Ref: SSOW03052021

Stephen Sowa
Moray House School of Education and Sport

Date: 25th May 2021

Dear Stephen,

Title: Primary school pupils' career aspirations and job automation risks

The School of Education and Sport Ethics Sub-Committee has now considered your request for ethical approval for the studies detailed in the above application.

This is to confirm that the Sub-Committee is happy to approve your application and that the research meets the School Ethics Approval criterion for this particular project. A standard condition of this ethical approval is that should any amendment, or deviation from the original protocol outlined in your application need to be made to carry out or continue your research, please notify the Ethics Sub-Committee at MHSES-Ethics@ed.ac.uk

The Committee also needs to be notified if there are any unexpected results or events once the research is underway that raise questions about the safety of the research.

Should you receive any formal complaints relating to the study you should notify the MHSE Ethics Committee immediately by email to MHSEthics@ed.ac.uk

Yours sincerely,

On behalf of:
Dr Fiona O'Hanlon
Convener, School Ethics Sub-Committee



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Ref: 2862

Stephen Sowa
Moray House School of Education and Sport

Date: 9th February 2021

Dear Stephen,

Title: Document Review: Primary School Pupils? Career Aspirations and Job Automation Risks

The School of Education and Sport Ethics Sub-Committee has now considered your request for ethical approval for the studies detailed in the above application.

This is to confirm that the Sub-Committee is happy to approve the application and that the research meets the School Ethics Level 1 criterion. This is defined as "your research project is completely desk-based (i.e. does not involve participants) and does not use information about living, identifiable individuals ('data subjects')".

A standard condition of this ethical approval is that you are required to notify the Committee, of any significant proposed deviation from the original protocol. The Committee also needs to be notified if there are any unexpected results or events once the research is underway that raise questions about the safety of the research.

Should you receive any formal complaints relating to the study you should notify the MHSE Ethics Committee immediately by email to MHSEthics@ed.ac.uk

Yours sincerely

On behalf of:

Dr Fiona O'Hanlon
Convener, School Ethics Sub-Committee

•EDINBURGH•
THE CITY OF EDINBURGH COUNCIL
COMMUNITIES & FAMILIES

Stephen Sowa

Date 27/05/21

Your ref

Our Ref MG/AF

Dear Stephen,

I am writing in response to your application requesting permission to undertake research in schools in The City of Edinburgh.

Your request has been considered, and I am pleased to inform you that you have been given permission in principle to undertake your research. I must stress that it is the policy of this Authority to leave the final decision about participation in research projects of this kind to Head Teachers and their staff, so that approval in principle does not oblige any particular establishment to take part.

I request that you forward a copy of your completed findings to me when they become available. In this case an electronic summary of your thesis would be preferred. Your work may be of interest to a number of staff in the Communities and Families Department.

I would like to thank you for contacting the Communities and Families Department about your work, and wish you every success in the completion of your project.

Yours sincerely

Martin Gemmell
Principal Psychologist

Appendix B: Demographics of Survey Respondents

Table 7 Primary school student survey respondents compared with the British primary school student population in 2017

Demographic group	No. of respondents (% of total survey respondents)	No. students (% of primary school student population) (Department of Education, 2017)
Pupils (aged 7)	2237 (19.35%)	630,906* (20.97%)
Pupils (aged 8)	2855 (24.70%)	634,046* (21.07%)
Pupils (aged 9)	3023 (26.15%)	596,329* (19.82%)
Pupils (aged 10)	2881 (24.92%)	574,463* (19.09%)
Pupils (aged 11)	564 (4.88%)	573,284** (19.05% classified in primary and secondary schools) (0.1% classified in primary schools only)
Pupils (girls)	5981 (51.13%)	1,478,320* (49.13%)
Pupils (boys)	5716 (48.87%)	1,530,708* (50.87%)
Pupils (FSM eligibility 0-10% at school level)	3096 (30.98%)	455,710* pupils applied for FSM (Breakdown per FSM eligibility bracket unavailable. Average % eligible for FSM in England = 15.3%)
Pupils (FSM eligibility 11-20% at school level)	1906 (19.07%)	
Pupils (FSM eligibility 21-35% at school level)	2498 (24.99%)	
Pupils (FSM eligibility 35-50%+ at school level)	2495 (24.96%)	
Pupils (Asian/Asian British)	1825 (19.27%)	399,200* (10.70%)

Pupils (Black/African/Caribbean/Black British)	497 (5.25%)	210,618* (5.60%)
Pupils (Mixed/Multiple ethnic group)	395 (4.17%)	221,397* (5.90%)
Pupils (Other ethnic group)	258 (2.72%)	86,583* (2.30%)
Pupils (White - English, Welsh, Scottish, Northern Irish, British)	5706 (60.25%)	2,519,639* (67.50%)
Pupils (White – Other)	790 (8.34%)	270,951* (7.30%)
Pupils (East Midlands)	608 (5.28%)	401,734 (7.30%)
Pupils (East of England)	544 (4.72%)	513,521 (9.33%)
Pupils (Isle of Man)	191 (1.66%)	
Pupils (London)	1760 (15.28%)	749,584 (13.62%)
Pupils (North East)	649 (5.64%)	223,499 (4.06%)
Pupils (North West)	2016 (17.50%)	648,712 (11.79%)
Pupils (Northern Ireland)	17 (0.15%)	169,908 in years 1-7 (3.09%)

Pupils (Scotland)	664 (5.77%)	400,312 in P1-P7 (7.27%)
Pupils (South East)	1664 (14.45%)	724,988 (13.17%)
Pupils (South West)	952 (8.27%)	415,838 (7.56%)
Pupils (Wales)	171 (1.48%)	243,595 in all ordinary and special classes (4.43%)
Pupils (West Midlands)	502 (4.36%)	521,268 (9.47%)
Pupils (Yorkshire and the Humber)	1779 (15.45%)	490,514 (8.91%)
Total UK school pupils (aged 7-11)	11,786***	3,822,843

*Data relating to England state-funded primary schools only

**Students aged 11 classified within state-funded primary and secondary schools

***For a confidence level of 95%, confidence interval of 0.9, percentage of 50%, a sample size of 11,820 would be needed

Table 8 Secondary school student survey respondents compared with the English secondary school student population in 2012

Demographic group	No. respondents (% of total survey respondents)	No. students (% of secondary school student population) (Department of Education, 2012)
Pupils (aged 13-14)	6254 (58.29%)	1,123,960* (53.57%)
Pupils (aged 15-16)	3882 (36.18%)	771,460* (36.77%)

Pupils (aged 17-18)	593 (5.53%)	202,615* (9.66%)
Total English school pupils (aged 13-18)	10,729**	2,098,035*

*England state-funded secondary schools only

**For a confidence level of 95%, confidence interval of 0.9, percentage of 50%, a sample size of 11,790 would be needed

Appendix C: Statistics from the Career Risk Analysis

Table 9 Descriptive statistics of British primary and secondary school students' career aspirations and associated technical probabilities of job automation

Age of respondents	Probability of automation (mean)	Probability of automation (std. deviation)	Number of respondents
7	.148	.192	2117
8	.152	.184	2643
9	.153	.179	2803
10	.156	.187	2684
11	.161	.199	526
13-14	.190	.254	6122
15-16	.207	.281	3787
17-18	.220	.300	580
Total	.175	.230	21262

Table 10 ANOVA results of British primary and secondary school students' career aspirations and associated technical probabilities of job automation

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Paramete r	Observed Power ^b
Corrected Model	11.694 ^a	7	1.671	31.796	.000	.010	222.569	1.000
	341.320	1	341.320	6496.015	.000	.234	6496.015	1.000
Intercept	11.694	7	1.671	31.796	.000	.010	222.569	1.000
Age	1116.749	21254	.053					
Error	1778.983	21262						
Total	1128.443	21261						
Corrected Total								

a. R Squared = .010 (Adjusted R Squared = .010)

b. Computed using alpha = .05

Appendix D: Protocol for the Systematic Review

Research questions:

- 1) In what ways are the approaches used in career aspiration intervention studies involving children addressing changing career conditions?
- 2) What tensions and gaps exist between career aspiration intervention approaches and the changing career conditions?

Objective: The objective of this study was to systematically search for, identify, and synthesise career aspiration intervention studies involving children. This was done to critically evaluate the ways in which recent intervention approaches have/have not addressed job change. This allowed for valuable insights and gaps to be identified in how children's career pursuits are being supported for the opportunities and risks of automation and job change.

Rationale for review: Career aspiration interventions may serve an important role in supporting young people's career pursuits and addressing persisting issues such as misalignments between aspirations and job supplies, as well as group disparities in occupational attainments. To achieve these goals, intervention approaches may benefit from addressing the rapidly changing conditions underlying careers. However, these conditions have become increasingly complex over recent decades due to increasing career transitions, job automation, and changes within occupations. Results from Study One revealed various career pursuit risks for school children and different subgroups. These risks are potentially diverse and nuanced, affecting some higher status roles, non-routine occupations, as well as routine roles. Due to this emerging complexity, it is important to review the approaches used in recent career aspiration interventions to gain insights and identify gaps in how they have addressed job change.

Design and method: A systematic review of literature was undertaken to extensively search and collate career aspiration intervention studies across different country contexts. A mixed studies review approach was used in this study. A mixed studies review approach combines qualitative and quantitative studies and uses an exhaustive search approach.

Design of studies included: Studies could involve either a pretest only, posttest only design, an experimental or a quasi-experimental pretest-posttest design (i.e., with or without randomisation being employed and allocation taking place at either the individual level or cluster level).

Types of participants in included studies: Studies can include participants between the ages of 5-18 years old (inclusive) of any nationality, sex, gender identity, sexual orientation, ethnicity, disability, or learning characteristics. Studies can be conducted in any setting worldwide.

Types of interventions included: Studies could report on any intervention (online or in-person) designed to influence or support the career aspirations of children. Studies were not included if they did not report on an intervention designed to influence the career aspirations of children, including studies exclusively reporting a natural process/unintended action concerning children's career aspirations.

Types of outcomes included: Studies need to report quantitative and/or qualitative data on participants' specific and/or typological career aspirations (at the individual and/or cluster level) collected pre- and/or post-intervention.

Publication date of studies included: Studies should be published between 1980-2021 (inclusive).

Publication language of studies included: Studies should be published in the English language.

Geographical spread of studies included: Studies and interventions can be conducted in any country.

Transparency of studies included: Studies should explicitly report the intervention study objectives, participants, context, content, methodology, and quantitative and/or qualitative data.

Proposed quality assurance procedures: To screen and select studies for the review an independent double screening procedure was employed. There was initial title and abstract screening of all records. This was followed by full text screening for those studies showing signs of meeting all the inclusion criteria. The lead researcher screened all 671 search results from the identified databases against the inclusion criteria. A separate researcher independently screened a random sample of these studies (33.38% of studies) to minimise individual errors and biases. The quality of the study design was not assessed.

Methods for coding/extracting data from included studies: Textual summaries of the features of each included study were made. This was done to build up categories covering the intervention approaches and to map their presence or absence. These features included the intervention topic and objectives, participant information, research design and measurement categories, intervention content, and publication details. Along with coding raw data or first-order constructs (e.g., participant-related data), it was also possible to code and describe the study authors' reasoning (i.e., second-order constructs) used to justify the intervention study objectives, measurement categories, and content.

Synthesis: A mixed methods approach to synthesis was used in this review. This approach enabled an integration of the qualitative themes with the descriptive statistics to facilitate a more reliable and in-depth analysis of the intervention approaches. The synthesis employed in this review combined the qualitative insights with the descriptive statistics under a unifying framework. SCCT and its proposed personal and environmental factors shaping career aspirations were used to structure the analysis. Textual/narrative-based analyses of the intervention approaches were developed under personal factors such as age, gender, socioeconomic background, as well as learning experiences and environmental barriers and supports associated with changing job markets.

Appendix E: Focus Group Guide

Opening remarks

A warm welcome to you all. Thanks for giving your time to attend this group discussion. This focus group will last no longer than 60 minutes. Today, we will be discussing your perspectives on the changing world of work and how your views are reflected in your programmatic work with children. If any question is asked that you would prefer not to answer, please say “pass” and I will move onto the next question. The questions are generally directed at the whole group. I will specify if/when a question is directed at a specific individual. Please note you are free to withdraw from the research at any point and every effort will be made to accommodate your preferences and keep to your pacing and time. Answers given during this interview will be anonymised and kept confidential. As mentioned in the content form and participant information sheet, you are free to withdraw consent at any time during the conversation.

Introduction

- 1) Please can you each introduce yourself and briefly explain your role on the programme team?

Conceptions of the changing world of work

- 1) What is your understanding of how the world of work is changing?
 - a. Are there particular technological, social, or economic developments that will significantly contribute to this change?
- 2) What occupations/sectors are likely to be more and less common in the future? Why do you hold this view?
 - a. What key skills will children require for future job markets?
- 3) How might different groups be impacted by automation and the changing world of work?
 - a. What gender, social class, or other group differences in career opportunities/risks could result from automation and job change?

Supporting children’s preparedness for the changing world of work

- 4) How is your understanding of automation and the changing world of work reflected in your programmatic work?
 - a. What topics and issues do you explore or emphasise with children?
- 5) In what ways do you support different groups of children?
- 6) From what age should children start being engaged in learning about the changing world of work? Why do you hold this view?

Practical challenges and opportunities in supporting children’s career preparedness

- 7) What opportunities or benefits does supporting children’s learning about the changing world of work offer?
- 8) What challenges do you face while supporting children’s learning about the changing world of work?

Appendix F: Interview Guide for Career Policymakers

Opening remarks

Thanks for giving your time to attend this interview. This interview will last around 30 minutes. Today, we will be discussing your experience developing and implementing the Career Education Standard, your conceptions of the changing world of work, and how children could be supported to prepare for automation and job change. If any question is asked that you would prefer not to answer, please say “pass” and I will move onto the next question. Every effort will be made to accommodate your preferences and keep to your pacing and time. Answers given during this interview will be anonymised and kept confidential. As mentioned in the consent form and participant information sheet, you are free to withdraw consent at any time during the conversation.

Introduction: Career Education Standard

- 1) Please can you introduce yourself and briefly explain your role at Education Scotland?
- 2) What was your involvement with developing/implementing the Career Education Standard?
- 3) What is your understanding of the Standard’s aim to improve children’s career learning and preparedness for the world of work?

Conceptualising the changing world of work

- 4) What is your understanding of how the world of work is changing?
 - a. Are there particular technological, social, or economic developments that will significantly contribute to this change?
- 5) What occupations/sectors are likely to be more and less common in the future? Why do you hold this view?
 - a. What key skills will children require for future job markets?
- 6) How might different groups be impacted by automation and the changing world of work?
 - a. What gender, social class, or other group differences in career opportunities/risks could result from automation and job change?

Supporting children’s preparedness for the changing world of work

- 7) In what way(s) does the Career Education Standard and the Curriculum for Excellence help to prepare children for the changing world of work?
 - a. What career learning experiences and outcomes are being promoted?
- 8) How are different groups of young people supported to prepare for the world of work?
- 9) From what age should children start being engaged in learning about the changing world of work? Why do you hold this view?

Practical challenges and opportunities in supporting children’s career preparedness

- 10) What opportunities or benefits does supporting children's learning about the changing world of work offer?
- 11) What challenges does supporting children's learning about the changing world of work present?

Appendix G: Participant Information Sheet

WHAT IS THE PURPOSE OF THE STUDY?

The purpose of this study is to explore the perspectives of policymakers and practitioners involved in children's career education and how they support young people for the changing world of work.

WHY HAVE I BEEN INVITED TO TAKE PART?

You are invited to participate in this study because you are currently working as a schoolteacher in Scotland and we would be interested to discuss your insights on how you understand the changing world of work, as well as the support you provide to students to aid their preparedness for their future careers.

WHAT WILL HAPPEN IF I DECIDE TO TAKE PART?

The researcher will contact you via email to arrange the interview at a time and day that is convenient for you. The interview will take place online (using Microsoft Teams or Skype) and you will be sent a link to join the call. We would like to audio record the interview (and will require your consent for this). While transcribing the interview dialogue and summarising the findings in research documentation, pseudonyms and other information concealment measures will be used to preserve your anonymity. The interview should take around 30 minutes to complete.

WHAT IF I WANT TO WITHDRAW FROM THE STUDY?

Agreeing to participate in this project does not oblige you to remain in the study nor have any further obligation to this study. If, at any stage, you no longer want to be part of the study, please inform the project lead: Stephen Sowa. Email:

. You should note that your data may be used in the production of formal research outputs (e.g., journal articles, conference papers, theses, and reports) prior to your withdrawal and so you are advised to contact the research team at the earliest opportunity should you wish to withdraw from the study. On specific request we will destroy all your identifiable answers, but we will need to use the data collected prior to your withdrawal, and to maintain our records of your consenting participation.

DATA PROTECTION AND CONFIDENTIALITY

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. While transcribing the interview dialogue and summarising the findings in research documentation, pseudonyms and other information concealment measures will be used to preserve your anonymity. If you consent to being audio recorded, all recordings will be destroyed at the completion of the research project (expected to be December 2023). Your data will only be viewed by the researcher/research team. All electronic data will be stored on a password-protected computer file. Your consent information will be kept separately from your responses in order to minimise risk. Data will be stored for a minimum of 5

years and may be used in future ethically approved research and publications with your consent.

WHAT WILL HAPPEN WITH THE RESULTS OF THIS STUDY?

The results of this study may be summarised in published articles, reports, presentations and included in a published doctoral thesis. Quotes or key findings will always be made anonymous in any formal outputs.

WHO CAN I CONTACT?

If you have any further questions about the study, please contact the lead researcher:

Stephen Sowa (Tutor & PhD Student, University of Edinburgh)

Email:

Tel: 07375095776

Moray House School of Education
University of Edinburgh
Edinburgh
EH8 8AQ



Appendix H: Participant Consent Sheet

Study Title: Understanding the complexities of supporting children's career aspirations and preparedness for the changing world of work

Please initial each box

1. I confirm that I have read and understood the Participant Information Sheet for the above study. ☐
2. I agree to have the audio from my interview recorded and I understand the audio recording will be destroyed upon completion of the research project. ☐
3. I have been given the opportunity to consider the information provided, ask questions, and have had these questions answered to my satisfaction. ☐
4. I understand that my participation is voluntary and that I can ask to withdraw at any time without giving a reason. ☐
5. I understand that my data and summarised findings will be pseudo anonymised and will be stored for a minimum of 5 years and may be used in future ethically approved research and publications. ☐
6. I agree to take part in this study. ☐

Name of person giving consent

Date

Signature

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Name of person taking consent

Date

Signature

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