Primary and secondary school students' career aspirations and job automation-related risks

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Abstract

To explore the differential impact of job automation for different groups of primary and secondary school students, an analysis of variance was conducted using survey data on the occupational aspirations of British school students (aged 7–18) and probability statistics derived from a model of job automation. 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 higher proportion of male students, lower socio-economic groups, and respondents knowing someone (particularly a parent) holding their desired occupation ($P < .05$).

Keywords Career aspirations · School students · Job automation

Résumé

Aspirations professionnelles des élèves de l'enseignement primaire et secondaire et risques liés à l'automatisation des emplois Afin d'explorer l'impact différentiel de l'automatisation des emplois pour différents groupes d'élèves du primaire et du secondaire, une analyse de la variance a été réalisée à partir de données d'enquête sur les aspirations professionnelles des élèves britanniques (âgés de 7 à 18 ans) et de statistiques de probabilité dérivées d'un modèle d'automatisation des emplois. Les résultats indiquent que les élèves âgés de 13 ans et plus étaient plus de deux fois plus susceptibles d'exprimer une aspiration professionnelle associée à un risque élevé d'automatisation, ainsi qu'une proportion plus élevée d'élèves de sexe masculin, de groupes socio-économiques inférieurs et de répondants connaissant quelqu'un (en particulier un parent) exerçant la profession souhaitée ($P < 0,05$).

Zusammenfassung

Berufswünsche von Schülerinnen und Schülern der Primar- und Sekundarstufe und Risiken der Arbeitsplatzautomatisierung Um die unterschiedlichen

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Auswirkungen der Automatisierung von Arbeitsplätzen für verschiedene Gruppen von Grund- und Sekundarschülerinnen und -schülern zu untersuchen, wurde eine Varianzanalyse durchgeführt, bei der Umfragedaten zu den Berufswünschen britischer Schülerinnen und Schüler (im Alter von 7–18 Jahren) und Wahrscheinlichkeitsstatistiken verwendet wurden, die aus einem Modell zur Automatisierung von Arbeitsplätzen abgeleitet wurden. Die Ergebnisse zeigten, dass Schülerinnen und Schüler ab 13 Jahren mit mehr als doppelt so hoher Wahrscheinlichkeit einen Berufswunsch äußerten, der mit einem hohen Automatisierungsrisiko verbunden war, zusammen mit einem höheren Anteil an männlichen Schülern, niedrigeren sozioökonomischen Gruppen und Befragten, die jemanden (insbesondere einen Elternteil) kennen, der ihren Wunschberuf ausübt ($P < .05$).

Resumen

Aspiraciones profesionales de los estudiantes de primaria y secundaria y riesgos relacionados con la automatización del trabajo Para explorar el impacto diferencial de la automatización del trabajo para diferentes grupos de estudiantes de primaria y secundaria, se realizó un análisis de varianza utilizando datos de encuestas sobre las aspiraciones ocupacionales de estudiantes de escuelas británicas (de 7 a 18 años) y estadísticas de probabilidad derivadas de un modelo de trabajo. automatización. Los resultados indicaron que los estudiantes de 13 años o más tenían más del doble de probabilidades de expresar una aspiración ocupacional asociada con un alto riesgo de automatización, junto con una mayor proporción de estudiantes varones, grupos socioeconómicos más bajos y encuestados que conocían a alguien (particularmente uno de los padres) manteniendo su ocupación deseada ($P < .05$).

Introduction

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). It has been argued the essential technical building blocks are in place for new technologies to substantially reshape workplaces, employment, and societies over the coming decades (Shackleton, 2020). In contrast, other scholars point out that past predictions of mass unemployment failed to materialise due in part to underestimates of the new jobs created through gains in productivity and the new occupations branching off newly automated roles (Autor, 2015). While debate about the scale and impact of job automation continues, the unique contemporary possibility for both routine and (more gradually) non-routine manual and cognitive work tasks to be computerised has potentially important implications for different groups which merit investigation, including for children and young people as future workers.

McKinsey Global Institute (2019), for example, concluded that a larger proportion of male workers may encounter increased occupational attainment difficulties in the next few decades primarily because they occupy the vast majority of highly

automatable manual labour-intensive jobs and comparatively fewer roles less susceptible to automation. Lower socio-economic groups and young people may especially face greater occupational pursuit/attainment risks as current entry level, lower-paying, and lower-skill occupations are increasingly subject to automation (Frey & Osborne, 2017; OECD, 2018). Crucially, because automation-related changes to labour markets and career pathways are predicted to take at least a decade or two to appreciably manifest (Frey & Osborne, 2017), current and forthcoming generations of children and young people could be uniquely impacted as automation-related changes may coincide with their important educational and career decision-making milestones.

A significantly changing landscape of work could present new risks for current and future generations pursuing and attaining certain types of occupations. These opportunity costs or occupational pursuit risks associated with job automation, such as suboptimal uses of time, monetary expenditure, career-related networking, and/or mental resources (Lent & Brown, 2020; Mann et al., 2020), may result from an individual's pursuit towards and/or attaining a specific occupation(s) relative to other occupations with a lower susceptibility to automation. Overlooking relevant information about which types of occupations are more or less likely to be subject to automation could have undesirable consequences for many current and future workers (Mann et al., 2020). Yet, these job automation implications for children's and young people's educational and career pursuits have thus far received limited attention in the career development literature (Hirschi, 2018). A key contribution of this study was therefore to investigate the occupational pursuit risks associated with job automation for different groups of school students and to discuss the implications for career education interventions and future research.

Estimating future job automation

Attempts to estimate the number of jobs at risk of automation across multiple countries have produced a range of results (McKinsey Global Institute, 2017; OECD, 2018), some as high as 47% in the United States (Frey & Osborne, 2017), while another estimate suggests 9% (Arntz et al., 2017). These projections all derive in large part from the work of Frey and Osborne (2017). To determine which existing occupations will be more susceptible to automation from a current technical feasibility standpoint, the researchers developed a model to account for likely engineering bottlenecks, such as those relating to creativity, social intelligence, and perception and manipulation in unstructured environments. In calculating computerisation probabilities for 702 current occupations (it is tentatively suggested the probabilities could be actualised within a decade or two), a wide-ranging group of technology experts were first brought together for a workshop held at the Oxford University Engineering Sciences Department to collectively assign a computerisation probability value to a sample of 70 occupations. These probability values considered the previously mentioned engineering bottleneck variables. An algorithm was subsequently devised

to reproduce these initial categorisations and to generate probability values for the remaining 632 occupations.

Using the calculated probabilities, the following economic sectors were identified as containing proportionally more occupations at medium or high risk of automation over the coming decades (computerisation probability values > 0.30): 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). Predominantly manual labour-intensive roles in industry and manufacturing and low-skill and low-wage occupations across multiple sectors are at greatest susceptibility for automation. Conversely, occupations in healthcare, education, legal, community service, arts, media, computing, engineering, science, management, business, and financial sectors will be at lowest risk of automation (Frey & Osborne, 2017, p. 267). Accordingly, it is the occupations composed of more non-routine tasks requiring originality, capabilities in the fine arts, negotiation, persuasion, social perceptiveness, and/or assisting and caring for others that will be at lowest risk of automation over the coming decades due to persistent engineering bottlenecks.

While Frey and Osborne's (2017) work provides a valuable insight on the potential impact of automation on jobs, it is important to recognise some methodological shortcomings. First, as the algorithm used to calculate the job computerisation probability values was designed to replicate the smaller sample of predictions proposed by the technology experts, it is questionable whether the subjectively calculated probabilities generated by the technology experts are sufficiently accurate (Arntz et al., 2017). Furthermore, to better estimate the likelihood human-occupied jobs will be entirely displaced by machines, a task-based analysis is considered a more precise way to model the impact of automation relative to an analysis at the occupational level (Autor, 2015). Since occupations consist of multiple tasks automation may affect some tasks, but not others. Thus, automation of a submaximal number of constituent tasks across multiple occupations may not necessarily result in the mass elimination of human-occupied jobs (Arntz et al., 2017). Companies' future adoption of new technologies, such as humanoid service robots, could also be limited by consumers' experiences of discomfort when interacting with such machines (Mende et al., 2019).

Despite these various limitations, the model developed by Frey and Osborne (2017) has offered researchers a useful model for forecasting the types of jobs most likely (from an engineering standpoint) to be subject to automation over the coming decades (Fuei, 2017). By using this model, an investigation into possible occupational pursuit risks across different groups could be conducted to yield potentially valuable findings to inform career education practice. To achieve this end, a reliable predictor of school students' educational and career-related pursuits and attainments was considered.

Students' career aspirations and predicting occupational pursuits

Career or occupational aspirations have been defined as individuals' expressed career-related goals at a particular moment in time (Rojewski, 2005). Career aspirations are considered distinct from career interests in that the former represents an individual's career-related goal(s) given ideal conditions, whereas the latter refers to an individual's emotional disposition towards certain career options (Rojewski, 2005). Multiple studies have found occupational aspirations in adolescence are some of the best predictors of later aspirations and occupational attainment in adulthood (Cochran et al., 2011; Schoon, 2001). For example, Schoon (2001) found the occupational aspirations expressed by UK 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 the natural sciences or healthcare. When compared with occupational expectations, evidence indicates adolescents' occupational aspirations play a comparable or more influential role in their career-related activities and attainments (Beal & Crockett, 2010; Saha & Sikora, 2008). However, it is questionable to what extent the utility and predictive power of occupational aspirations extends to those expressed by pre-adolescents.

Though some have asserted 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(s) (Gore et al., 2017), other scholars have contended that primary school children's career aspirations are more stable than previously thought to be the case (Chambers et al., 2018; Hughes & Kashefpakdel, 2019). Pertinent to these claims, past longitudinal research in the USA using panel data found participants' career aspirations remained largely stable across a year (Trice, 1991). Moreover, recent large-scale survey results involving over 10,000 British primary school students found participants aged 7–8 expressed similar proportions of career aspirations by sector as those aged between 9 and 11 (Chambers et al., 2018). Subsequently, when these survey results were compared against survey results pertaining to British secondary school students (aged 15–18) (Mann et al., 2013), discernible yet insignificant proportional differences in career aspirations were observed.

More specifically, although noticeably fewer 17–18-year-old British students expressed career aspirations in the art, culture, entertainment, and sports sector compared with those aged 7–8 years old (16% versus 44%, respectively), in the vast majority of other sectors (13 out of 16) similar proportions were evident across the different age groups (Rogers et al., 2020, pp. 8–9). Longitudinal research using panel data on school students in the United States similarly reported an insignificant proportional change in students' career aspirations between primary and secondary education. Tracking changes in the occupational aspirations of 65 American students as they progressed from second to twelfth grade, similar percentages were found to hold career aspirations in the social (34% versus 38%), investigative (25% versus 20%), and enterprising (20% versus 15%) categories, while moderately larger changes were evident in the artistic (12% versus 5%) and conventional occupational categories (2% versus 12%) (Helwig, 2003, p. 27).

In sum, school students' career aspirations offer one of the most reliable insights into their future career-related activities and attainments. While the career aspirations of primary school students are less predictively reliable at the individual level than those of secondary school students, when considered in the aggregate, concerning the type(s) of occupational aspiration expressed, they are sufficiently predicable to serve as a valuable indicator in estimating school students' occupational pursuits (and associated risks) across primary and secondary education. Because these risks have the potential to vary across students and subgroups, theoretical perspectives on career aspirational development were considered to elucidate the relevant factors determining children and young people's career aspirations and pursuits.

Theoretical perspectives on career aspirational development

In explaining the career aspiration development of children, Gottfredson (2002) proposes a theoretical framework using concepts of career circumscription and compromise. It is argued that between the ages of 3 and 5 children begin orienting themselves to size and power—gradually learning more about the realities of adulthood and developing schemas about being an adult and holding an occupation. When children reach 6–8 years old, they begin orienting themselves based on perceived sex roles, resulting in the emergence of gender stereotypical thinking about careers. Careers perceived as inappropriate for their sex are then eliminated or circumscribed from further consideration. Between the ages of 9 and 13, an orientation towards social valuation is thought to occur which similarly results in the circumscription of career options inconsistent with their perceived position in the social hierarchy. After students have progressed beyond primary education (age 14 and beyond), they orient themselves to their internal, unique self. Students 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 and perceived barriers such as those relating to social prestige and gender (Gottfredson, 2002).

While the theory of career circumscription and compromise offers valuable insights into children's formation of career aspirations, research suggests additional psychosocial constructs specified in other career aspiration theory can offer important predictive factors as well (Baker et al., 2014; Gore et al., 2015). Thus, this study drew on a supplementary theoretical framework which integrates concepts from multiple career development theories and derives from Social Cognitive Theory. Social Cognitive Career Theory (SCCT) theorises that an individual's accumulated learning experiences, as mediated by their personal inputs (e.g. biological predispositions, gender, ethnicity, etc.) and environmental affordances, influences the subsequent development of their self-efficacy beliefs and outcomes expectations, which in turn shape the formation of their career-related interests, goals, and actions (Lent & Brown, 2019).

Therefore, high self-efficacy beliefs relating to the tasks of which an occupation is comprised, in conjunction with the perceived desirability and expected outcomes of this occupation, will play a central role in determining whether or not an individual

develops an interest and aspiration for a given occupation or industry (Sheu & Bordon, 2017). Perceived and/or actual barriers and supports from the background environment and proximal environment experienced during choice making (e.g. job markets) are additionally relevant for understanding under which conditions individuals will form career aspirations and make actual career choices (Lent & Brown, 2019). This potentially includes pursuing occupations based on an understanding of what might emerge or disappear as a result of automation (Hirschi, 2018). As SCCT specifies a range of personal and environmental factors shaping individuals' career aspirations, empirical studies covering several of these key factors influencing children and young people's career aspirations were reviewed in the following sections.

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

School children's gender has been found to be moderately predictive of their career aspirations over various country contexts (Chambers et al., 2018; Nikel, 2021). Large studies involving primary school students from the UK and 19 additional countries (aged 7–11), along with research concerning 22,136 American students aged between 13 and 16, both found average gender-based differences in occupational aspirations for people-centred versus thing-centred jobs (Chambers et al., 2018; Howard et al., 2011). More females on average expressed aspirations for occupations involving substantial interaction with people (e.g. nurse, hairdresser). Conversely, male students' career aspirations more often entailed working with things/objects (e.g. builder, engineer).

Chi-square analyses by Auger et al. (2005) found the career aspirations of female students in lower primary school were more gender stereotypical than those in upper primary school. However, as female students entered secondary school and reached twelfth grade, career aspirations reverted to being more gender stereotypical. There is also emerging evidence concerning secondary school students (across five racial groups) in the USA and primary school children in the UK that suggests a higher proportion of female students expressed aspirations for higher prestige occupations and jobs requiring higher levels of education than male students (Chambers et al., 2018; Howard et al., 2011). According to SCCT, the differing learning experiences male and female students accumulate, including varying academic achievement, can contribute significantly to career aspiration divergences.

Parental influences through encouragement and behaviour modelling are also recognised to contribute to the formation of children's career aspirations within SCCT. Studies with primary school students have reported a moderate association between children's occupational aspirations and their parents' actual occupations (Trice & Knapp, 1992). In further support, a study exploring students' career aspirations at age 12 found that those holding high-status career aspirations and expectations frequently had parents who also held high-status career aspirations and expectations for their children (Creed et al., 2007). In research conducted by Schuette et al. (2012), male primary school students' career aspirations were more aligned with the occupations held by male adults in the home, while female pupils' aspirations misaligned with both parents in more cases. As the role modelling and support from

parents has a conceivably relevant impact, a hypothesis was formulated that children with parents holding highly automatable jobs are more likely to pursue higher-risk occupations.

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

Children's socio-economic background has additionally been examined as a potentially important determinant of their career aspirations. Research carried out by Moulton et al. (2018) concerning British children aged 7 concluded 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 circumstances. The influence of socio-economic background on aspirations also appeared operative across British ethnic groups. Gutman and Akerman (2008) reported British female ethnic minorities from high socio-economic backgrounds held higher career aspirations than their counterparts from lower socio-economic backgrounds.

Though these studies highlight the influence of socio-economic background on primary school students' aspirations, multiple studies have found the effect size to be small relative to other variables (Baker et al., 2014; Gore et al., 2015). For instance, Gore et al. (2017), carrying out a multivariate analysis of the career aspirations of 6492 students (aged 8–18) from 64 public schools in Australia, 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.

Research goal

The review of literature indicated that higher proportions of preadolescent school students express aspirations for creative-intensive (non-routine) occupations, students with parents holding high-status/wage occupations are more likely to hold comparable occupational aspirations, more female students hold aspirations for social-intensive roles, and higher socio-economic students hold more aspirations for high-wage/status occupations. Consequently, there was reason to conjecture that these subgroups of school students may be less likely to aspire to occupations at high technical risk of automation because more routine, manual labour-intensive, and low-wage/status occupations are predicted to be technically more susceptible to automation (Frey & Osborne, 2017). Accordingly, four hypotheses were formed: (1) preadolescent school students are less likely to express aspirations for occupations associated with a higher technical risk of automation; (2) students with parents holding occupations at low technical risk of automation are less likely to express higher-risk aspirations; (3) female students are less likely to express aspirations for occupations associated with a higher technical risk of automation; and (4) higher socio-economic students are less likely to express aspirations for occupations associated with a higher technical risk of automation.

According to SCCT, young people's beliefs and knowledge about future job markets could additionally be a relevant factor in shaping their aspirations and preparedness for future job markets Though school students' expectations, beliefs, and knowledge about future jobs could not be studied as independent variables in this research, past survey results (approximately 1000 British students aged 11–18 years old in formal education) indicate a majority of school students (71%) have expressed concern that it will be more difficult to a get a job in 2030 due to automation and changing job types (Speakers for Schools, 2018). The undesirable consequences arising from school students' possibly limited knowledge and beliefs to develop well-informed career aspirations provide further justification to explore students' potential occupational pursuit risks. Thus, by investigating primary and secondary students' and subgroups' aspirations for certain types of jobs and the associated technical probabilities of automation, better designed interventions can be devised to aid students and subgroups in their occupational preparations and pursuits.

This study addressed the following research question: what differences exist among British primary and secondary school students and various subgroups in aspiring to occupations at technical risk of automation over the next few decades?

Methods

Participants

To address this research question, a secondary data analysis was undertaken using datasets covering the career aspirations of British primary and secondary school students and various subgroups, along with probability statistics on job automation. Bringing these large quantitative datasets together meant more generalised inferences about job automation-related risk differentials across various groups of British school students could be tentatively made. To represent the career aspirations of contemporary primary school pupils and different subgroups most accurately, the first dataset was chosen based on being one of the most recent and largest surveys of primary school students' and subgroups' career aspirations in the UK and 19 additional countries. These data were collected in 2017 and presented in a report entitled Drawing the Future (Chambers et al., 2018).

The raw anonymised survey data were obtained on request from the lead partner and inspected for missing or inaccurately recorded data. In total (discounting unidentifiable responses), 11,786 responses from primary school students aged seven to eleven were collected from 146 primary schools across 12 regions (and the Isle of Man) of the UK using a quota sampling technique. Comparing the survey data against student demographic data collected by the Department for Education (2017), the sample was broadly representative of the gender, age, ethnic, and regional makeup of the country's primary school students (size of the population was 3,822,843 and a 95% confidence level was approximately attained). Although, pupils from Northern Ireland were significantly underrepresented, survey responses from the non-British respondents (5848 primary school pupils from 19 other countries) were not included in this data analysis due the high probability the small

sample sizes did not reliably reflect the career aspirations of the wider populations of primary school students (most countries had less than 500 respondents). Data files containing further information on the UK and international survey respondents are accessible in the specified data repository.

Measure

All respondents were invited to draw and write down the name of the job they aspire to hold when they reach adulthood on a pre-prepared questionnaire. They were also asked to answer a question about whether they personally knew someone who held the occupation they drew, and, if not, how they knew about the job. To enable a comparison between the responses of the primary school students and those from another survey of British secondary school students, respondents' expressed career aspirations were coded into a list of 69 distinct occupations deriving from the UK Commission for Employment and Skills occupation data.

To estimate the socio-economic status of each UK respondent, information was collected by the lead partner on the total percentage of students eligible for Free School Meals (FSM) in each school participating in the survey. These data were used as indicators to differentiate students from lower (21–50%+FSM eligibility) and higher socio-economic backgrounds (0–20% FSM eligibility). A study by Taylor (2018) suggests FSM eligibility can be a reliable proxy for identifying socio-economically disadvantaged students. However, as the measurement undertaken in Chambers et al. (2018) research does not relate to individual respondents' FSM eligibility, rather, FSM eligibility at the school level, this measure may have somewhat over- or underestimated the number of respondents eligible for FSM.

To compare these data with students' career aspirations at the secondary education level, separate survey responses from 10,729 secondary school pupils were also drawn on. These responses pertain to a cohort of English students aged between 13 and 18 as collected in March–April 2012 by the b-live Foundation and subsequently included in a published report entitled Nothing in Common (Mann et al., 2013). Data were broken down by age groups, but other demographic information was not available from this dataset. The approach used for coding respondents' career aspirations was identical to the one used for the primary school respondents. Lastly, to estimate the probability specific occupations are at technical risk of automation over the next decade or two, the figures calculated by Frey and Osborne (2017, pp. 269–278) covering 702 occupations and their respective probability of computerisation (from an engineering standpoint only) were used.

Procedure

Subsequent to listing the distinct occupational aspirations expressed by the primary and secondary school student respondents, a corresponding job computerisation probability value, taken from the study by Frey and Osborne (2017), was paired with each distinct occupational aspiration. In cases where a direct match between a distinct occupational aspiration and one of the 800 occupations with computerisation

probability values could not be achieved, one of two courses of action was taken. If a closely related alternative(s) to the occupation aspiration was available (e.g. physicists, chemists, and biologists closely matched the distinct occupational aspiration of scientist), the alternative's computerisation probability value was used or the mean of multiple closely related alternative probabilities were used (or the median value for a skewed distribution). In cases where no closely related occupation could be matched to the aspiration (e.g. celebrity, social media and gaming, astronaut, politician), no probability value was assigned. Less than 7% of respondents expressed occupational aspirations which could not be assigned a computerisation probability value (6 out of 70 distinct career aspirations). These occupations are nonetheless likely to be at low risk of automation due to their high number of constituent tasks requiring significant creativity and/or social intelligence.

Data analysis

Concerning all four hypotheses and the specified subgroups of school students (covering age, gender, parental occupation, and eligibility for FSM), the proportions of survey respondents expressing each distinct occupational aspiration were calculated. Subsequently, for each subgroup, the percentages of pupils expressing high-risk career aspirations (17 occupations with a probability ≥ 0.66), medium-risk career aspirations (10 occupations with a probability > 0.33 and < 0.66), and low-risk career aspirations (37 occupations with a probability ≤ 0.33) were summed. The decimal thresholds for low, medium, and high roughly correspond to those employed by Frey and Osborne (2017). Furthermore, a univariate analysis of variance was conducted using SPSS to estimate between-subjects effects, including significance, partial eta squared, and observed power values for several independent variables (including age, gender, parental occupation, and eligibility for FSM). This analysis method was chosen to determine if the variability in respondents' aspirations for occupations associated with a particular probability of automation (from an engineering standpoint only) could be reasonably attributable to one or multiple independent variables.

Results

Age differences in aspirations for occupations at low and higher risk of automation

Results from this secondary data analysis corroborated the first hypothesis, revealing that significantly larger proportions of secondary school students are aspiring to occupations at medium and high technical risk of automation relative to students in primary school. Around 7.43% of British primary school students (aged 7–11) reported aspirations for occupations at medium or high technical risk of automation, with relatively small differences between those aged between 7–8 (6.42%) and 9–11 years old (8.26%). However, this figure almost triples for English pupils aged

13–14 years old (20.6%). Further increases were observed for those between aged 15–16 (22.2%) and 17–18 years old (25%) (Figure 1).

Primary and secondary school respondents' age was found to be statistically significant independent variable, $P = .000$, $\eta p^2 = .010$, and power $= 1.0$ (Tables 1, 2). Pronounced 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 broader range of sectors. Though some of these differing job aspirations are associated with lower-risk sectors such as legal, professional, scientific, and technical, the majority relate to higher-risk sectors such as construction, retail, trade, motor vehicle maintenance, and manufacturing (Frey & Osborne, 2017).

Parent-related differences in aspirations for occupations at low and higher risk of automation

At the primary school level, respondents' disclosure of whether they knew someone who held their expressed career aspiration was found to be statistically significant, $P = .000$, $\eta_p^2 = .006$, and power $= 1.0$ (knew someone: $M = .140$, SD $= .204$, $N = 4006$; did not know someone: $M = .161$, SD $= .175$, $N = 6519$). Slightly more respondents expressing medium- or high-risk aspirations vis-a-vis 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). Corroborating the second hypothesis, the most notable difference in this respect was
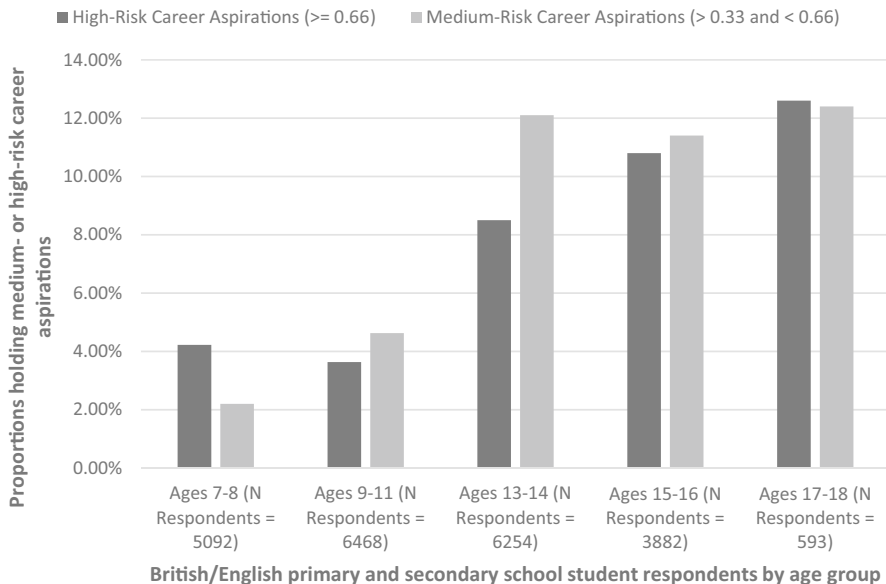

Figure 1 Proportions of British primary and secondary school pupils aspiring to occupations at medium or high technical risk of automation

Table 1 Descriptive statistics concerning 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	21,262

between respondents knowing a parent holding an occupation which matched their aspiration (47.32% versus 22.62%, respectively). While in other cases of aspiration-occupation alignment, such as with another member of the respondent's extended family (29.46% versus 33.03%, respectively) or a friend (19.05% versus 18.51%, respectively), differences were noticeably smaller. For those 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).

Gender differences in aspirations for occupations at low and higher risk of automation

Results from the data analysis also corroborated the third hypothesis, indicating a higher proportion of British male students are aspiring to occupations at both medium and high risk of automation (combined totals: 9.19% versus 5.77%). A statistically significant effect for the respondents' gender was found, $P=.000$, $\eta_p^2=.013$, power$=1.0$ (boys: $M=.209$, SD$=.192$, $N=4238$; girls: $M=.104$, SD$=.165$, $N=4820$). Male students on average were more likely to express occupational aspirations involving substantial interaction with objects/things and female students were more likely to aspire to people-centred occupations on average.

Socio-economic differences in aspirations for occupations at low and higher risk of automation

The results from this data analysis suggest that the fourth hypothesis was not conclusively demonstrated as differences between socio-economic groupings at the primary school level were not clear enough to be statistically significant, $P=.049$, $\eta_p^2=.001$, and power$=.645$ ($\leq10\%$ FSM eligibility: $M=.144$, SD$=.169$, $N=2886$; $>35\%$

Table 2 Univariate analysis of variance concerning 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	Non-cent. parameter	Observed power[b]
Corrected model	11.694[a]	7	1.671	31.796	.000	.010	222.569	1.000
Intercept	341.320	1	341.320	6496.015	.000	.234	6496.015	1.000
Age	11.694	7	1.671	31.796	.000	.010	222.569	1.000
Error	1116.749	21,254	.053					
Total	1778.983	21,262						
Corrected total	1128.443	21,261						

[a]$R^2 = .010$ (Adjusted $R^2 = .010$)

[b]Computed using alpha = .05

FSM eligibility: $M = .162$, SD $= .204$, $N = 2324$). Of the students attending schools with a FSM eligibility classification $> 20\%$, around 7.73% expressed career aspirations at medium or high risk of automation. Whereas slightly fewer students (6.98%) attending schools with a FSM eligibility classification $\leq 20\%$ did. Both boys and girls in the lower socio-economic category expressed slightly 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%). The significance of these different factors in (re)orienting school children towards certain career pathways associated with potentially different automation-related risks are discussed in the next section.

Discussion

Explaining students' job automation-related risks from primary to secondary school

As highlighted in the results, around the age of 13–14 students express a marked reorientation towards occupations associated with a higher risk of automation, particularly those classified historically as conventional and realistic (e.g. accountant and mechanic). This career aspirational shift post-primary school could be attributed to various psychosocial processes or combinations of personal and environmental factors. When considered through the framework of SCCT, between primary and secondary school students will accumulate learning experiences (mediated by their personal inputs and environmental affordances) about a growing range of occupations. This can lead to new and/or revised career-related self-efficacy beliefs and outcomes expectations, which will in turn serve to (re)shape their career interests and aspirations (Lent & Brown, 2019). In particular, research indicates students' individual achievement experiences in education (actual and comparative) and gender may play a more influential role in (re)shaping their career aspirations than their socio-economic affordances (Gore et al., 2017).

Yet, it remains difficult to account for the marked aggregate change in career aspirations between the short time frame of 11 to 13–14 years of age solely in terms of incremental changes in SCCT-based constructs. Because SCCT offers no explicit 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 provide a more complete insight. Gottfredson (2002) proposes that around the age of 14 individuals will orient towards a more internalised, unique conception of self. This encompasses a heightened concern for their own distinctive attributes and predilections which modulates their former conception of self as primarily derived from external similarities with others (e.g. sex stereotypes). The resulting new or significantly revised self-beliefs and personal values may therefore markedly modify individuals' more specific beliefs (and expectations) about executing a course of action in particular career domains. Combining these theoretical explanations could better elucidate why a significant diffusion, rather than a mass widening of expressed occupational aspirations occurs over a short age period.

Whether career and school educators should try to mitigate or redirect such changes in self-related beliefs and career aspirations is debatable. It may be argued that such an aggregate shift in students' career aspirations is not of any significant consequence. This is because even if the job automation predictions assumed in this study are largely accurate, young people can readily change their career aspirations or educational and career-related decisions post-secondary school without incurring significant losses. Moreover, the uncertainty in predicting future job markets also raises doubts as to whether children's learning about the changing landscape of work offers greater advantages than disadvantages. Learning about the possibility of job automation may cause some anxiety in children and lower their self-efficacy beliefs. Moreover, career education provisions based on inaccurate assumptions about future job markets may disseminate counterproductive information about the relevant skills and jobs to consider.

Conversely, the results from this study indicate there could be potential occupational pursuit risks for many children as they progress through primary and secondary school. By learning about the plausible risks and opportunities associated with future job markets during secondary and/or primary schooling, a young person maybe better informed to pursue pertinent work-related skills and select a desirable degree programme, training provision, apprenticeship, or an occupation associated with a lower likelihood of automation. This in turn may reduce their need to change career path or pursue additional study, thereby reducing potentially large financial, time, and psychological costs. Acquiring knowledge about the changing landscape of work may also serve to enhance children's self-efficacy beliefs and outcome expectations which may otherwise be vulnerable to erosion if/when the changing job market presents them with unexpected roadblocks. By being more aware of both the possible advantages and disadvantages in actively preparing school children for the changing world of work, educators can make more considered decisions about their career-related teaching.

The influence of different psychosocial factors on students' aspirations for higher-risk occupations

With the results from this study drawing on the survey responses of primary school children, including their self-reports about knowing someone holding an occupation they aspire to attain, possible reliability issues such as memory recall accuracy should be recognised as well as the underdetermined causal power of the independent variables. Nevertheless, the results from the secondary data analysis tentatively suggest that students with a parent(s) who holds an occupation with a higher susceptibility to automation may more likely be exposed to and subsequently adopt a higher-risk career aspiration. As proposed in SCCT, via observation and imitation of personally identifiable models such as parents, children can learn career-related behaviours, information, values, beliefs, expectations, and may potentially develop corresponding occupational aspirations (Creed et al., 2007). Parents, as role models and experienced workers, are perhaps in a position to help engage their children in broad and critical discussions about their career and the changing world of work more generally. Ongoing

collaborations between parents and career educators may help to ensure consistent and accurate information can be shared with the children.

With regard to gender differences, a higher proportion of British male students were found to be aspiring to occupations at both medium and high risk of automation primarily due to their lower average proclivity towards people-centred occupations. Although this average interest difference and the presently higher average educational attainment of girls may well orient a higher proportion of female school students towards potentially lower-risk careers, SCCT highlights other relevant factors to consider in understanding career pursuits. In particular, average gender-based differences in outcome expectations (e.g. girls being potentially less likely to form career goals deriving from status or money considerations) may be relevant (Kang et al., 2019). This may provide a counteracting force influencing some proportion of female students to aspire to lower-paying occupations, with these occupations being at potentially higher risk of automation (OECD, 2018). Because of these competing forces and uncertainties in the actual speed of job automation across different economic sectors, career education provisions should be cautious in making gender-related assumptions about job automation-related risks. Yet, there perhaps remains opportunity to engage both male and female students in critical exploration of the psychological and social factors leading towards differences in career-related choices and possible future risks and opportunities.

Differences in occupational pursuit risks across different socio-economic groups were less clear in this study. Multiple explanations could be offered to explain these small differences. First, close to 50% of the primary school respondents are below the age of nine. Accordingly, there is theoretical and empirical support to assume that those below this age largely did not express career aspirations incorporating social class judgements (Auger et al., 2005; Gottfredson, 2002). Second, as apparent in other studies, 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). Alternatively, the limitations of the proxy used to estimate respondents' socio-economic background may have meant that an over- or underestimate of the number of individual students eligible for FSM has prevented a clearer statistical picture from emerging.

Whether a larger difference between socio-economic groups will emerge as students progress into secondary school could not be statistically examined in this study. But, a similar multinational data analysis carried out on secondary school students' career expectations across multiple countries found a clearer disparity in job automation-related risks across socio-economic groups (Mann et al., 2020). As it remains unclear exactly how many presently lower-status or low-paying jobs will be automated and created relative to higher-status or high-paying jobs (OECD, 2018), tailored career education provisions for different socio-economic groups should be carefully considered.

Limitations

This secondary data analysis did not have access to panel data to track the career aspirations of individual students across primary and secondary school. The two distinct survey results included in this study are nonetheless consistent with past

longitudinal research using panel data in affirming an aggregate increase in traditionally realistic (and potentially higher risk) career aspirations over the primary and secondary school period (Helwig, 2003). As future job markets depend on many technological, social, and economic variables and thus remain difficult to accurately predict (with wide disparities across different job automation predictions), the results generated in this study using one model of job automation should be viewed as tentative and as indicating a possible career development issue requiring further exploration. Future research might draw upon more up-to-date and empirically informed models of job automation and panel data across compulsory and tertiary education to address some of these limitations.

Conclusion and implications

This study sought to estimate and explain the potential occupational pursuit risks primary and secondary school students and various subgroups could encounter over the next few decades based on the technical job automation probabilities calculated by Frey and Osborne (2017). A secondary data analysis found possible risk differences across age and gender groupings. Male students' greater average proclivity towards thing-centred occupations versus people-centred occupations may largely explain why higher occupational pursuit risks were found for this subgroup. Moreover, considered through the framework of SCCT, the marked increase in higher-risk career aspirations post-primary school could be attributable to students' expanding learning experiences of a broader range of occupations (including more conventional jobs). Taken together with students' accumulating personal and socio-economic barriers (perceived and actual), these factors may serve to modify their career-related self-efficacy beliefs, outcome expectations, career aspirations, and career pursuits thereafter. However, this aspirational shift maybe more fully explained by a developmental process occurring around the age of 14 in which young people place a heightened emphasis on their self-uniqueness (Gottfredson, 2002).

There are several practical considerations for school and career educators in helping primary and secondary school students prepare for and pursue jobs of the future. Learning about the changing world of work may cause anxieties in some school children and/or lead to misinformation or misunderstandings about the potential complexities associated with future job markets (e.g. how some traditionally high- as well as low-status jobs could be automated). Educators may well consider age-appropriate scaffolding of the content, including exploring general principles and learning heuristics (e.g. how creative and social job tasks might be harder to automate) to limit misunderstandings. At this early stage of enquiry, tailoring career education provisions to address possible automation-related risk differences across groups of students should be undertaken with caution. Further research can help to (re)test and elaborate on the study results using different country datasets and multivariate analysis techniques.

Declarations

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