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Longitudinal case study analyses of young people following STEM trajectories

ASPIRES is a 13-year-long research study that highlights the factors that positively or negatively influence youth's Science, Technology, Engineering and Mathematics (STEM) trajectories. There is a need for this research because the UK currently faces a STEM-skills gap, with STEM-related sectors reporting a shortage of skilled individuals. ASPIRES suggests that the factors that stop young people from attaining further in their science education ultimately play a huge role in the lack of young professionals in STEM careers. Over the years, various surveys and in-depth interviews of young people's science and career aspirations were collected to compile the data I used for my research project. My project focused on the third phase of the research (ASPIRES3), tracking the STEM trajectories of the participants, now aged 20-23. My project focused on how factors, such as social class and ethnicity, influence youth's post-16 Science education and career trajectories.

At the start of my placement, I met with the ASPIRES team and chose **three** research questions to investigate:

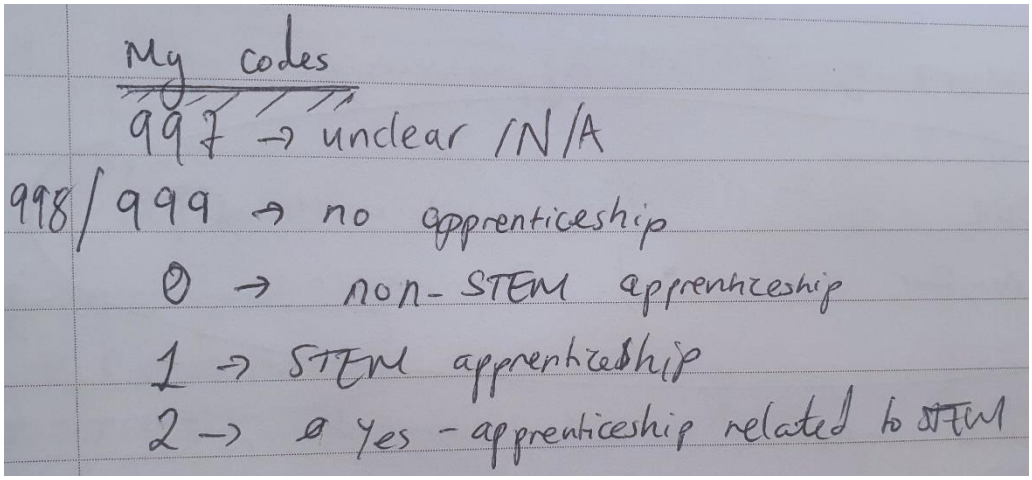
1) **Who is doing an apprenticeship?**
    - *What are the ethnic identities and gender identities of the apprentices?*
2) **Are there patterns in apprenticeship participation? Why?**
    - *What are these patterns?*
3) **Do the experiences of STEM and non-STEM apprentices differ?**
    - *How are the experiences of STEM and non-STEM apprentices similar? In what ways do they differ?*

I was given access to relevant ASPIRES databases and used existing apprenticeship data to conduct my analyses using IBM's Statistical Package for the Social Sciences (SPSS). I used SPSS and Excel spreadsheets to explore survey and interview responses related to my research aims and obtain findings. The overall sample contained 7635 participants, 210 of whom were apprentices.

Before conducting any statistical analysis, I started sorting data on each apprentice in the study. I thematically arranged each apprenticeship course into three main categories: STEM, STEM-allied and non-STEM, using open coding on SPSS. I used the ASPIRES coding sheet to decide which apprenticeship courses were STEM, STEM-related (STEM-allied) and non-STEM. The coding sheet was helpful because it ensured consistency with previous phases of the research across partner organisations. The codes used to arrange the apprenticeship data are as follows:

0- Non-STEM apprenticeship
1- STEM apprenticeship

2- STEM-allied apprenticeship



210 apprenticeship courses were successfully coded, with two excluded from further analysis (code '997'- invalid) because the course was unclear.

- **Non-STEM (38.1%), N=83**
    - Examples: Policing, solicitor (Law), plastering
- **STEM (21.4%), N=45**
    - Examples: Aerospace engineering, software developing, data analytics
- **STEM-allied (40.5%), N=80**
    - Examples: Accountancy, health and social care, automotive mechanic

Who are the apprentices?

I began my statistical analysis by exploring demographic data from the ASPIRES database to investigate my first research question. I used SPSS to investigate variables, including *indices of multiple deprivation (IMD) quintile, ethnicity, and gender*. I used cross-tabulation analysis to compare the demographic variables with each apprenticeship category and tested for statistical significance. Fisher's exact tests were used to determine importance due to low counts in some samples, especially within STEM. Initially, I expected a significant correlation between (IMD) quintile and apprenticeship type, but no specific correlation was observed. I learned that (IMD) quintile alone might not be the most reliable variable to obtain findings on socioeconomic background because a young person can live at a postcode classed as '1' (highest) on the index but have a low household income. Instead, I focused my analyses on the gender and ethnicity variables.

- **Gender**

  The apprenticeship categories were compared against the gender identities (self-reported) of the apprentices. A list of genders, including non-binary, was included in the survey, but due to very low counts, non-binary were excluded from the analysis.

In addition, *prefer not to say* and *skipped* responses were excluded. Therefore, the overall apprenticeship sample size for gender was (N=196), and for STEM apprentices, (N=43).

		Overall sample (N=7635)	Apprenticeship sample (N=196)	STEM apprentice sample (N= 43)
Gender	**Woman**	**4529 (62.1%)**	**88 (44.9%)**	**7 (16.3%)**
	Man	**2739 (37.6%)**	**107 (54.6%)**	**36 (83.7%)**
	Other [Please specify]	20 (0.30%)	1 (0.50%)	0 (0.0%)

***Examples of statistically significant results**

Overall, women were significantly under-represented in apprenticeships compared to men across the overall and apprenticeship sample ($p<0.05$). This relationship was especially acute in the case of STEM apprenticeships, with only seven women participating in a STEM course. To better understand these findings, I also conducted a literature review to explore other research on the gender disparity within STEM apprenticeships. The WISE campaign's *"Not for people like me?" Under-represented groups in science, technology and engineering*[1]. The paper highlights that STEM apprenticeships can be viewed as masculine. This perspective from adults within schools (such as career advisors or teachers) or at home can hinder young women from believing that STEM is for 'people like [them]'.[2] The report mentions that at around age 10, pupils begin to self-identify as 'non-STEM'. This is propagated by teachers, who generally have lower stereotypical expectations of under-represented groups in STEM[3]. Thus, a combination of the child's low self-efficacy and teacher expectations seemingly perpetuates a young woman's non-STEM identity, which persists throughout her school career, even if she excels academically at STEM (girls outperform boys in qualifications across all school years).[4] Therefore, when it is time for young women to consider their post-16 options, it comes as no surprise when they do not feel like STEM apprenticeships or traditional degrees are for people like them. Interestingly, another article mentions that using gender-neutral language when advertising STEM apprenticeships in job advertisements and person specifications could help more young women to participate.[5]

- **Ethnicity**

  The apprenticeship categories were compared against the ethnic identities reported by the apprentices. Students who preferred not to disclose their ethnicity or skipped the question were not included in the data analysis.

[1] https://www.wisecampaign.org.uk/wp-content/uploads/2021/07/not_for_people_like_me.pdf
[2] Ibid.
[3] Ibid., p.6
[4] Ibid.
[5] https://link.gale.com/apps/doc/A585375636/ITOF?u=ucl_ttda&sid=bookmark-ITOF&xid=f7388289

		Overall sample (N=7635)	Apprenticeship sample (N=205)	STEM apprentice sample (N=43)
Ethnicity	**White**	5974 (78.2%)	177 (86.8%)	34 (79.1%)
	South Asian	**706 (9.2%)**	**17 (7.8%)**	**8 (18.6%)**
	Mixed	**415 (5.4%)**	**7 (3.4%)**	**1 (2.3%)**
	Black	**286 (3.7%)**	**4 (2.0%)**	**0 (0.0%)**
	Other (incl. East Asian and Middle Eastern)	**140 (1.8%)**	**0 (0.0%)**	**0 (0.0%)**

***Examples of statistically significant results**

The data reveals that racially minoritised young people were significantly under-represented compared to white youth across the overall and apprenticeship sample ($p<0.05$). This relationship was particularly acute in STEM apprenticeships, especially with **no** Black apprentices or apprentices from Other ethnic identities. The findings complement broader literature on the influence of racial disparities on youth engagement within STEM.[6][7][8] The articles also argue that Black students are among the most underrepresented ethnic minorities in apprenticeships, especially in STEM[9]. Though it can be argued that racially minoritised young people may have less awareness about apprenticeships or their benefits, it is more convincing that unequal access to STEM is caused by racial prejudice.[10]

Interestingly, South Asian youth were under-represented in the overall sample but were over-represented in STEM.

Are there patterns in apprenticeship participation? Why?

To investigate my second research question, I focused my statistical analysis on variables that explored how the apprentices accessed their apprenticeships and why they chose to enrol. To select these variables, I was given access to the original survey questions and set the relevant questions I wanted to include in my findings.

- **[Q58] How did you first find out about your apprenticeship?**

  Overall, 40% (N=86) of apprentices discovered their apprenticeship through an advertisement, whilst only 17% (N=36) discovered their course through school or college. The National Audit Office mentions that because of limited funding, schools may not provide enough opportunities to explore alternative pathways

[6] https://www.tuc.org.uk/sites/default/files/tucfiles/apprenticeships_nov2011.pdf
[7] file:///N:/Downloads/Levels-of-success-the-potential-of-uk-apprenticeships.pdf
[8] https://books.google.co.uk/books?id=3YxFBgAAQBAJ&dq
[9] https://www.tuc.org.uk/sites/default/files/tucfiles/apprenticeships_nov2011.pdf
[10] https://www.suttontrust.com/wp-content/uploads/2019/12/Levels-of-Success3-1.pdf

to university.[11] And because of this, they may not have enough incentive to provide unbiased guidance to their students. The paper suggests that providing schools with more incentives and improving career services can tackle the issue.[12]

- **[Q59] Thinking about your apprenticeship, and the other options you were considering doing, was an apprenticeship your first choice?**

  One hundred thirty-four apprentices (64.4%) answered 'Yes'.

  Overall, STEM and STEM-allied apprentices were more likely to have chosen an apprenticeship as their first choice ($p<0.05$).

  Those who did not choose an apprenticeship as their first choice were asked [Q60].

- **[Q60] What was your first choice?**

  Most apprentices initially chose to attend university (39.2%) or work (37.8%).

  71.4% of STEM apprentices chose university as their first choice ($p<0.05$).

  For non-STEM, 54.1% chose employment without study ($p<0.05$).

The results suggest that not only do young people who aspire to STEM education after compulsory education are not only more likely to continue their STEM trajectories but also to access further education. This could be for several reasons, and if I were to investigate this further, I would attempt to explore this potential association.

Do the experiences of STEM and non-STEM apprentices differ?

Finally, my analysis concluded by investigating whether the experiences of STEM and non-STEM apprentices differed and how. I will summarise some of the key similarities and differences that I observed.

[11] https://dera.ioe.ac.uk/31299/1/Delivering-STEM-Science-technology-engineering-and-mathematics-skills-for-the-economy.pdf
[12] Ibid.

- **[Q87] Next, thinking about your decision to do an apprenticeship rather than do something else. Looking back over the last year, do you think this was the right or wrong decision?**

Overall, apprentices said they made the right decision (96.9%), slightly lower than the proportion of STEM apprentices who answered the same (100%).

- **Q98 part 1- I feel well supported in my career development by my employer – how much do you agree with the following statement?**

Q98 p1	Frequency of all apprentices (%)	Frequency of STEM apprentices (%)
Agree	158 (77.1%)	37 (84.1%)
Neither agree nor disagree	35 (17.1%)	5 (11.4%)
Disagree	12 (5.8%)	2 (4.5%)

Overall, the data shows that most apprentices felt supported in their career development by their employers. However, slightly more STEM apprentices agreed with the statement, which is not a significant result. To further explore experiences of career/further education support, I investigated Q101.

- **Q101- If you needed good quality information, advice or guidance about your future education/training and/ or work, would you know where to go or who to speak to?**

Q101	Frequency of all apprentices (%)	Frequency of STEM apprentices (%)
Yes	137 (75.7%)	34 (85.0%)
No	44 (24.3%)	6 (15.0%)

Overall, most apprentices knew where to go for support concerning their futures. However, a slightly higher proportion of STEM apprentices agreed more with the statement than other apprentices (though not statistically significant). Q98 p1 and Q101 may suggest that STEM apprentices feel better supported with their futures than other apprentices.

Overall conclusions on the data

Apprenticeship participation is unequal for many young people, though it is meant to be a fairer alternative to traditional higher education pathways. Tackling the inequalities that hinder access to apprenticeships generally, such as making apprenticeship advertisements and courses more welcoming for other genders, is the first step. Improving access to apprenticeships by addressing gender and racial inequalities will ultimately result in similar changes to STEM apprenticeship participation. The ASPIRES project takes a holistic and

multifaceted approach to addressing this problem, centring around young people's identities, suggestions and reasons behind their education and career choices. Therefore, any solution that results from this research should also focus on youth's science experiences and identities rather than assuming their motivations or experiences within STEM.

Personal reflections

I have learned many things during my time with the ASPIRES team. I am grateful that I had the opportunity to become familiar with coding and statistical analysis using SPSS. The guidance from the team has undoubtedly helped me prepare for my quantitative research module in the new academic year. The experience has also helped me to set personal goals and achieve collective team goals. Having weekly plans and mini projects enhanced my discipline and time management skills and diversified my experience in research. For example, I was allowed to create a communications plan for a report on young people's visions for science and filmed a video for the report launch. This was great for me because I had a variety of things to do during my placement instead of looking at statistics the entire time. I found the mini projects interesting because making education more equitable is very important to me. Specifically, with the communications plan, I learned that researchers also need to be familiar with producing engaging and concise content. I worked with team members to create tweet-like narratives to potentially share with different audiences, such as education activists I looked up to when I did my GCSEs or organisations like the Sutton Trust. It taught me that research has elements of creativity where I can bring in my interests without losing sight of the project aims.

I am thankful that I also got to present my research findings to partner organisations, including the CEO of the Education Endowment Foundation (EEF), which I was initially very nervous about doing. The lesson I took from this experience is to be confident even if my audience is much more accomplished than me in research, the charity sector, education, and other fields. Often, it can be easy to look at accomplished individuals and doubt what I can offer them, but when I presented my findings, it was encouraging to know that they learned something new. Furthermore, sharing what I knew and being open to questions and feedback helped me learn from their incredible wealth of knowledge and helped me to learn how I could better my research. It was also good to connect with individuals making an impact on social justice within education, which school does not necessarily expose me to.

One of my main struggles with my placement was adapting to unexpected changes. During the last weeks of my project, there was an issue with my coding which resulted in my initial categorisation of the data changing. This meant that most of my data was incorrect, so my analyses would need to be rerun, my research writeup changed, and I would need extra time to do all this. At first, I was upset because it felt like a huge undertaking, and I was not prepared to essentially repeat 4-5 weeks of work in 2 weeks. But, after an honest conversation with my supervisor and working through my concerns with her, we devised a plan. She helped me by rerunning all my syntax logs and compiled a final output file for me. I learned that when unexpected challenges happen, it is not a time to get inward-focused or think I've failed but be honest, ask for some help and work

through it. It helped a lot to have her and other team members check over my work and support me in redoing my write-up, and the final version turned out much better than the first.

Overall, I thoroughly enjoyed my placement; it was an honour to sit in a room where an award-winning researcher keeps herself motivated with pictures of her family, team, and quotes. It was inspiring to present to an audience of seasoned professionals and get constructive feedback to improve my research skills. Finally, even though it was challenging to have mishaps along the way, bouncing back from it with the help of a team is rewarding. And now, I have a complete project and an unforgettable experience that I am very proud of.