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GC Insights: Space sector careers resources need a greater diversity of roles

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Abstract. Educational research highlights that improved careers education is needed to increase participation in STEM. Current careers resources concerning the space sector, however, are found to perhaps not best reflect the diversity of roles present and may in fact perpetuate misconceptions about the usefulness of science. We, therefore, compile a more diverse set of space-related jobs, which will be used in the development of a new space careers resource.

1 Introduction

Educational research shows participation issues across Science Technology Engineering and Mathematics (STEM) are not due to school students' disinterest, but whether students see these fields and their potential career opportunities as for "people like me" (Archer and DeWitt, 2017, and references therein). These perceptions form early and remain relatively stable with age, which has led to recommendations for increased provision and quality of careers education/engagement at both primary and secondary levels (Archer et al., 2013; Holman, 2014; Davenport et al., 2020). Careers education provision in the UK specifically, however, is still not universal (despite mandates being in place) and that which is provided can often be patterned by societal inequities, unfortunately leaving some students' aspirations "dampened" (Abrahams, 2016; Archer and Moote, 2016; Moote and Archer, 2018a,b). It is therefore fair to say that high quality careers-related materials are in demand by schools now more than ever.

A key problem in STEM participation is the perception that studying science is only for those that aspire to become scientists (Archer and DeWitt, 2017). This is in contrast with the wide range of careers both related to and beyond science that further STEM education can enable. Therefore, this "science = scientists" link needs to be broken by highlighting to young people and their key influencers (e.g. teachers, parents/carers, community leaders) the prevalence and relevance of STEM subjects to everyday life and a diverse selection of potential career paths (Archer and DeWitt, 2017; Davenport et al., 2020; Archer et al., 2021).

Good practice towards diversity in communications more generally may be gleaned from the numerous efforts aimed at improving the diversity within STEM fields, due to the under-representation of women, disabled people, and those from ethnic-minorities or socially-disadvantaged groups (Campaign for Science and Engineering, 2014). One common approach is to strive for equal representation of minority demographics, in for instance role models, so that those aspiring towards STEM can see

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"people like me" in those fields which may help tackle damaging stereotypes (e.g. Huntoon and Lane, 2007; Prinsley et al., 2016; González-Pérez et al., 2020). In other words, equal weight should be given to all categories, irrespective of whether they constitute a majority or minority within society.

In this paper, we investigate the representation of the space sector within current careers resources to ascertain whether they align with these educational recommendations.

2 Current space careers resources

The space sector involves a wide range of activities which are conventially split into upstream (making and sending objects to space, e.g. space manufacturing and operations), downstream (using these objects to deliver products/services for exploitation, e.g. space applications), and ancillary services (providing specialised support), with scientific activities potentially spanning all three (e.g. Sadlier et al., 2019; Sant et al., 2021; know.space, 2021). Reports suggest that in the UK alone there are 45,100 space-related roles employed in industry (not including academia), constituting 0.14% of the total workforce, with these roles supporting 126,300 jobs across the supply chain and generating £6.6 billion to the UK economic output, 0.30% of the gross domestic product (know.space, 2021). Space-related roles should thus be rife for inclusion in careers education resources.

The 2020 Space Census was the first national survey of the UK space workforce (Thiemann and Dudley, 2021), inclusive of both industry and academia. It provides, to our knowledge, the best current classification scheme and breakdown of the diverse roles present within the UK space sector. These are shown to the right of Figure 1. This scheme and data are used as a benchmark for assessing current space careers resources.

We undertook desk research to find what careers resources for young people currently exist within the UK. This revealed four sets of space careers resources with at least 5 roles: Edge Barrow School (2017), European Space Education Resource Office (2021), SpaceCareers.uk (2021), and University of Edinburgh Careers Service (2016). The jobs featured in each of them were then classified using the space census scheme. This was performed independently by multiple coders with overall 91% agreement and a Cohen's κ of 0.9 (where 0 would be expected at random and 1 indicates perfect agreement; McHugh, 2012). Breakdowns of each set of resources by category are shown as the first four stacked plots in Figure 1. Chi-squared tests for each resource were also performed under two different null hypotheses. The first of these was for a uniform distribution, which would best highlight the diversity of the space sector as mentioned earlier. The second corresponded to the distribution of the space census, which would indicate resources were at least representative of the sector. In both cases, due to small numbers, p-values were computed via 10,000 Monte Carlo simulations of the χ^2 statistic for each resource's sample size under the null hypothesis. These are listed in Figure 1 below each stacked plot.

Our results show that, to high confidence, none of the current space careers resources adopt a uniform distribution of the different categories (expected 11% for each, corresponding to 1–3 roles). Therefore, they are perhaps not best representing the diversity of space-related careers available. Indeed, several of the categories are not included at all: management and administration in Edge Barrow School; education, policy, and administration in ESERO; sales and education in SpaceCareers.uk; management, computing, education, and administration in the University of Edinburgh.

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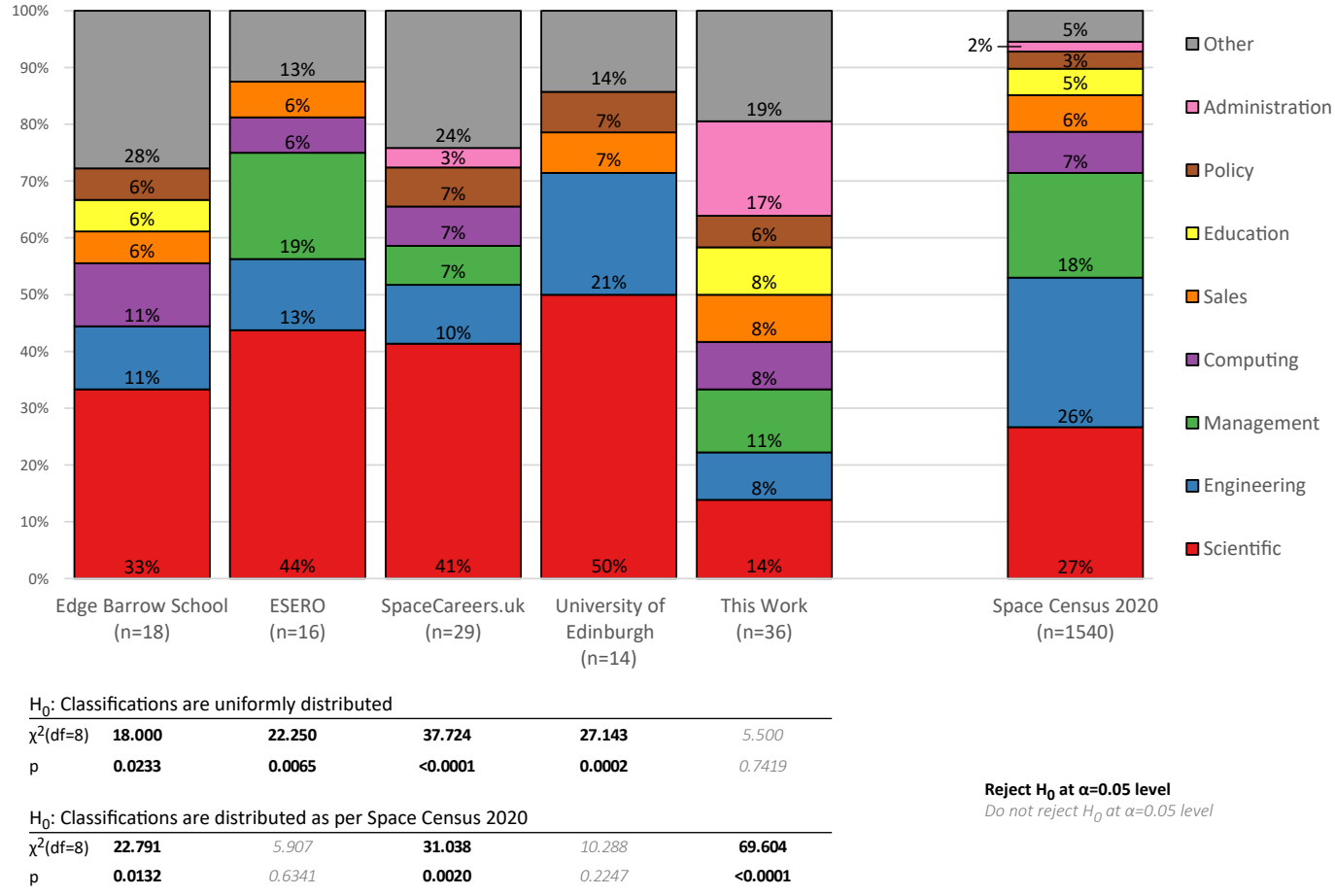

H_0: Classifications are uniformly distributed

χ^2(df=8)	**18.000**	**22.250**	**37.724**	**27.143**	*5.500*
p	**0.0233**	**0.0065**	**<0.0001**	**0.0002**	*0.7419*

H_0: Classifications are distributed as per Space Census 2020

χ^2(df=8)	**22.791**	*5.907*	**31.038**	*10.288*	**69.604**
p	**0.0132**	*0.6341*	**0.0020**	*0.2247*	**<0.0001**

Reject H_0 at α=0.05 level
Do not reject H_0 at α=0.05 level

Figure 1. Breakdown of current UK space sector careers resources compared to the UK Space Census 2020 (Thiemann and Dudley, 2021). The outcomes of chi-squared tests from these distributions are also shown.

Comparing the resources' distributions to that of the space census, we find that all of them over-represent (academic/research) scientific careers. Given the low levels of young people aspiring towards being a scientist from an early age (Archer and DeWitt, 2017), it appears that these resources may perpetuate misconceptions about the usefulness of science. On the other hand, the large proportions of "Other" careers across all resources means that several less traditional career options related to space are being highlighted, which is advantageous. The statistics indicate the Edge Barrow School and SpaceCareers.uk resources are highly unrepresentative of the UK space sector, whereas for ESERO and the University of Edinburgh we cannot confidently reject this null hypothesis (though these two sets have the smallest number of roles).

Finally, we note that all these resources are targeted at upper-secondary and university students. Therefore, there appears to be a lack of space-related careers material aimed at the ages most in need of engagement, i.e. primary and lower-secondary students (Archer et al., 2013; Holman, 2014; Davenport et al., 2020).

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3 Developing a new resource

Given these findings, we endeavoured to create a more diverse set of UK-based space careers for a new resource to be aimed at younger ages. This was achieved by contacting Imperial Space Lab's industrial partners, reading reports on the UK space sector (e.g. Sadlier et al., 2019; Sant et al., 2021; know.space, 2021), finding advertised vacancies, and more general online research. The list of roles was iterated several times until it was felt the final set of 36 careers, greater in number than current resources, well captured the diversity of the sector. The roles chosen were:

- Artist
- Astrobiologist
- Astrophysicist
- Business Development
- Communications
- Data Scientist
- Earth Observation
- Environmental Engineer
- Finance
- Flight Software
- Flight Surgeon
- Geologist
- Ground Software
- Human Resources
- Independent Cost Estimator
- Innovation Manager
- Journalist
- Museum Curator
- Policy Maker

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- Product Assurance
- Project Manager
- Risk Management
- Satellite Sales
- Science Communicator
- Space Command
- Space Lawyer
- Space Nutritionist
- Space Operations Nurse
- Space Psychologist
- Space Travel Agent
- Structural/Mechanical Engineer
- Supply Chain
- Systems Engineer
- Teaching Fellow
- Technical Recruiter
- Weather Data Analyst

Our aim was that this set would have near-equal weight in each classification. The breakdown is shown as the fifth stacked plot in Figure 1 along with results of the statistical tests. These reveal that our set is indeed consistent with a uniform distribution, hence better representing the sector's diversity. Consequently, it is significantly different from the space census, though importantly no majority classification from the census is over-represented. As with existing resources, "Other" careers form a significant fraction of the set thereby highlighting less traditional paths. It is also worth noting that the high number of roles in administration, i.e. relating to the running of a business or organisation, was deliberate since "business" is by far the most popular aspiration amongst young people (Archer et al., 2013).

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4 Conclusions

Educational research has highlighted that improved careers education, particularly for younger ages, may be required to improve participation in STEM. This needs to highlight the diversity of career options STEM subjects can enable, breaking the misconception that science is only for scientists. Focusing on space-related careers, we have found that currently available UK resources perhaps do not best represent the diversity present in the sector. In particular, there is an over-representation of scientists within them, which may instead perpetuate stereotypes. We have, therefore, compiled a more diverse set of space-related careers which does not appear to suffer from these issues. These roles will form the basis of a new space careers resource for primary and lower-secondary students, which we hope will better align with the recommendations from recent educational research.

Data availability. Data supporting the findings are derived from listed public domain resources.

Author contributions. MOA was involved in the conceptualization, funding acquisition, supervision, formal analysis, visualization, and writing of this work. CLW and SD designed the methodology, performed the investigation, and undertook data curation. SF contributed to project administration and supervision. AP provided resources and assisted with validation.

Competing interests. The authors declare that they have no conflict of interest.

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References

Abrahams, J.: Schooling inequality: aspirations, institutional practices and social class reproduction, phdthesis, Cardiff University, http://orca.cardiff.ac.uk/id/eprint/100310, last accessed: 20 December 2021, 2016.

Archer, L. and DeWitt, J.: Understanding Young People's Science Aspirations: How students form ideas about 'becoming a scientist', Routledge, London, UK, https://doi.org/10.4324/9781315761077, 2017.

Archer, L. and Moote, J.: ASPIRES 2 project spotlight: Year 11 students' view of careers education and work experience, techreport, King's College London, London, UK, http://bit.ly/ASPIRES2Careers, last accessed: 20 December 2021, 2016.

Archer, L., Osborne, J., DeWitt, J., Dillon, J., Wong, B., and Willis, B.: ASPIRES Young people's science and career aspirations age 10-14, Tech. rep., https://kclpure.kcl.ac.uk/portal/en/publications/aspires-report(a0237ac7-cb43-473e-879a-1ea0addff0e3).html, last accessed: 20 December 2021, 2013.

Archer, M. O., DeWitt, J., Davenport, C., Keenan, O., Coghill, L., Christodoulou, A., Durbin, S., Campbell, H., and Hou, L.: Going beyond the one-off: How can STEM engagement programmes with young people have real lasting impact?, Research for All, 5, 5–23, https://doi.org/10.14324/RFA.05.1.07, https://arxiv.org/abs/2003.06162, 2021.

Campaign for Science and Engineering: Improving diversity in STEM, Tech. rep., http://www.sciencecampaign.org.uk/resource/ImprovingDiversityinSTEM2014.html, last accessed: 20 December 2021, 2014.

Davenport, C., Dele-Ajayi, O., Emembolu, I., Morton, R., Padwick, A., Portas, A., Sanderson, J., Shimwell, J., Stonehouse, J., Strachan, R., Wake, L., Wells, G., and Woodward, J.: A Theory of Change for Improving Children's Perceptions, Aspirations and Uptake of STEM Careers, Res. Sci. Educ., https://doi.org/10.1007/s11165-019-09909-6, 2020.

Edge Barrow School: UK space sector knowledge sheet, Tech. rep., Edge Barrow School, https://www.edgbarrowschool.co.uk/assets/Uploads/About-Us/Departments/Careers--WRL/Files/UKSpaceSectorKnowledgeSheet.pdf, last accessed: 23 July 2021, 2017.

European Space Education Resource Office: Careers in space, https://www.stem.org.uk/esero/careers-space, last accessed: 23 July 2021, 2021.

González-Pérez, S., Mateos de Cabo, R., and Sáinz, M.: Girls in STEM: Is It a Female Role-Model Thing?, Frontiers in Pyschology, 11, 2204, https://doi.org/10.3389/fpsyg.2020.02204, 2020.

Holman, J.: Good career guidance, techreport, Gatsby, London, UK, https://www.linkschool.org.uk/wp-content/uploads/2016/11/gatsby-good-career-guidance.pdf, last accessed: 20 December 2021, 2014.

Huntoon, J. E. and Lane, M. J.: Diversity in the geosciences and successful strategies for increasing diversity, Journal of Geoscience Education, 55, 447–457, https://doi.org/10.5408/1089-9995-55.6.447, 2007.

know.space: Size & health of te UK space industry 2020: Summary report for the UK Space Agency, Tech. rep., know.space, London, UK, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/987497/know.space-Size_Health2020-SummaryReport-FINAL_May21.pdf, last accessed: 20 December 2021, 2021.

McHugh, M. L.: Interrater reliability: the kappa statistic, Biochemia Medica, 22, 276–282, https://doi.org/10.11613/bm.2012.031, 2012.

Moote, J. and Archer, L.: Failing to deliver? Exploring the current status of career education provision in England, Research papers in education, 33, 187–215, https://doi.org/10.1080/02671522.2016.1271005, 2018a.

Moote, J. and Archer, L.: Essays on Employer Engagement in Education, chap. Who is getting prepared? Year 11 students' views on careers education and work experience in English secondary schools, Routledge, London, UK, https://doi.org/10.4324/9781315144115, 2018b.

https://doi.org/10.5194/gc-2022-1
Preprint. Discussion started: 20 January 2022
© Author(s) 2022. CC BY 4.0 License.

Prinsley, R., Beavis, A. S., and Clifford-Hordacre, N.: Busting muths about women in STEM, techreport 13, Office of the Chief Scientist, Australian Government, https://doi.org/https://about.uq.edu.au/files/6036/busting-myths-about-women-in-stem.pdf, last accessed: 20 December 2021, 2016.

Sadlier, G., Flytkjær, R., Sabri, F., and Esteve, R.: Size & health of the UK space industry: A report to the UK Space Agency, techreport, London Economics, London, UK, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/774450/LE-SHUKSI_2018-SUMMARY_REPORT-FINAL-Issue4-S2C250119.pdf, last accessed: 20 December 2021, 2019.

Sant, R., Roe, P., Osborne, E., Hallam, L., and Sullivan-Drage, H.: Space Sector Skills Survey 2020, techreport, BMG Research, Birmingham, UK, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/964639/BMG_2081_UKSA_Space_Sector_Skills_Survey_2020_Report_V1.pdf, last accessed: 20 December 2021, 2021.

SpaceCareers.uk: SpaceCareers.uk Job profiles, https://spacecareers.uk/?p=job_profiles, last accessed: 23 July 2021, 2021.

Thiemann, H. and Dudley, J.: Demographics of the UK space sector, Tech. rep., Space Skills Alliance, https://spaceskills.org/census-demographics, last acessed: 03 December 2021, 2021.

University of Edinburgh Careers Service: Your future in.... space industry, Tech. rep., University of Edinburgh, https://www.ed.ac.uk/files/atoms/files/yfi_space_2016.pdf, last accessed: 23 July 2021, 2016.