

The importance of educating students about careers in the space sector: a student perspective

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Abstract—The UK space sector is rapidly expanding, seeing a 6.4% compound annual increase in employees since 1999/2000 and an average of 39 new companies entering the industry every year since 2012 [1]. Such growth rates are likely to increase as the UK works toward its goal to capture 10% of the global space market by 2030 [1]. To accommodate for this increase in employee demand and avoid the inevitable skills shortage which generally arises in specialist roles, an increased number of capable students will need to join the workforce year on year [2]. The UK Space Agency has recognised the important role of outreach throughout a student’s academic career, in the pipeline of developing a skilled workforce [3]. While outreach activities, especially those aimed at younger students, should cultivate a general interest in space and the activities of the sector, in this paper we will highlight the necessity of expanding the scope of activities covered. Many of the existing outreach programmes tend to focus on technical subjects such as engineering, for example less than 20% of projects which ran as part of the Principia education campaign addressed non-STEM subjects [4]. This is unrepresentative of the sector, with approximately 50% of roles in the European Space Agency (ESA) being non-technical [5]. Furthermore, at the ages where students start to think about career options, they must be made aware of the careers and pathways available. This will guide the choices they make with respect to further and higher education, and encourage them to develop certain required skills early, potentially reducing the skills shortage as they enter the sector. We will therefore explore the importance of careers- focused outreach and consider methods for this, including initiatives such as the SpaceCareers.uk educational online resources and events. The discussions in this paper will focus on the UK, but are relevant to all nations looking to grow their space sector.

Keywords— *careers; space sector; education; students; outreach*

I. INTRODUCTION

The UK has a growing share in the global space market, which the UK Space Agency aims to increase to 10% by 2030. Industry and academia work to provide cutting edge space technology and science, develop novel ways to apply space derived data, and manufacture space hardware; with 40% of all small satellites currently in orbit having been built in the UK [6]. In addition, the UK has become an attractive place to build space businesses, with the number of space related start-ups increasing more than three-fold between 2014 and 2018 [1]. As the sector grows, it requires more graduates to join the workforce, with an anticipated 30,000 new jobs in the next 10

years [1]. Thus, students must be educated about the job opportunities available within the space sector, in order to sufficiently supply the pipeline.

This paper aims to highlight the importance of educating students of all ages on space-related jobs by discussing (1) the awareness of space-related jobs in both technical and non-technical fields; (2) views on the attainability of space-related jobs; and (3) the current demand for careers resources. It will then go on to consider how these can be addressed through existing educational resources, and in some cases proposed modifications.

In this paper, technical jobs have been defined as those which require sector specific knowledge (typically STEM related roles), e.g. planetary scientist, data scientist, and engineer; non-technical jobs are those which focus on business knowledge and communication skills, e.g. those in finance, administration, and management.

II. APPROACH TO DATA COLLECTION

A. Purpose-built surveys

Data has been collected by UKSEDS (the UK’s national student space society) specifically for the purpose of this paper, through surveys distributed to schools and universities across the UK, as well as directly to individuals through official social media channels. A diverse range of students, studying a spectrum of disciplines were encouraged to take part, regardless of their interest in pursuing a career in the space sector.

These surveys were tailored for students across three age categories: (1) 8-13 year olds (n = 179), (2) 14-18 year olds (n = 102), and (3) those over 18 years old (n = 164). These boundaries were chosen to correspond with ages where students are typically thinking and making decisions about the next stage of their education. The surveys asked about knowledge and aspirations of jobs in the space sector; what, if any, space related activities respondents have taken part in and the extent to which they were taught about space jobs; and what advice they would like to receive related to space careers. Some questions remained constant across all three surveys to allow for comparison between the different age groups, however, many were omitted or rephrased for the sake of relevance. In some cases, open-ended questions were used to find the extent of respondents’ knowledge and opinions

regarding the sector, so responses had to be generalised and categorised.

B. Aggregated UKSEDS event surveys

UKSEDS collects survey data at all of its events including the annual National Student Space Conference (NSSC), the largest student space event in the UK, and their trademark Careers Launch events, which focus on jobs and routes into the space sector. These surveys typically represent students with a prior interest in space, from school students (age 14+) to PhD students, studying a range of technical and non-technical disciplines. It is worth noting that data from all UKSEDS surveys are self-reported, and cannot be independently verified.

III. WHY DO WE NEED TO EDUCATE STUDENTS ABOUT CAREERS IN THE SECTOR?

A. Increase awareness

In order to adequately satisfy the growing demand for employees within the space sector, students need to be made aware of potential careers paths which they can work towards. This could encourage them to consider a career which they hadn't previously known about, or could help to foster their interest in particular subjects, making them more likely to invest time in developing skills needed within the sector.

Students' awareness of jobs within the sector has been compared across the surveyed age groups by averaging the instances in which a job is named across the respondents, when they were they were asked to list 5+ jobs (Fig. 1).

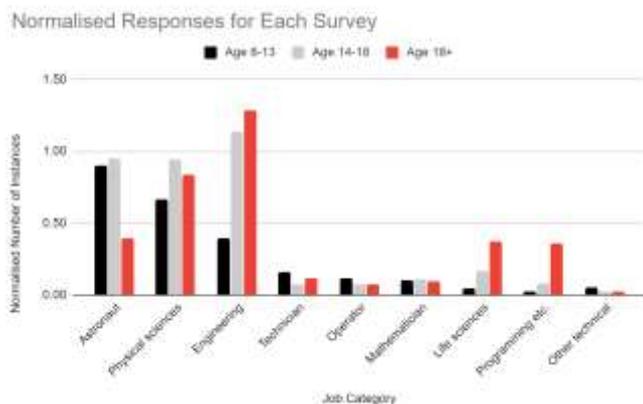


Fig. 1. Normalised responses when students 8-13 (n=179), 14-18 (n=102), & 18+ (n=164) were asked to list 5+ space related jobs.

It was observed that students are more aware of the relevance of engineering to the space sector, than any other profession; with respondents aged 14+ typically naming more than one type of engineering role. This is likely to be because these roles are typically depicted in movies and in classic outreach activities such as building rockets. However, this awareness was not frequently seen to translate to knowledge of engineering as a job; an observation also reported by Engineering UK [7].

In a sector heavily reliant on complex software and programming, it is clear more needs to be done to show the applicability of roles such as programmers, computer scientists, and software engineers. 'Data scientist' was named by 6% of respondents aged 18+, by 1% aged 14-18, and not at all by those aged 8-13, indicating a wide lack of awareness of this role. Data science is fundamental in areas such as Earth Observation, a part of the sector whose income has grown in the UK at a rate of 25% per year since 2014/15 [1]. Artificial intelligence, machine learning, and quantum computing have the potential to revolutionise missions, both on the ground and in space, due to their high processing capabilities. However, this can only happen if enough qualified graduates are aware that their skills are highly sought after in the space sector. Many students studying computer science, who took the survey, believe that they are studying the 'wrong subject' to work in the space sector, and so would not look to go into such jobs after graduation. Therefore, it is important that students with these technical qualifications and interests are educated about the opportunities for them to apply their skills to the space sector.

The UK has also been involved with several life science research projects, including astrobiology experiments on board the Rosalind Franklin rover and human space physiology experiments on board the International Space Station such as the Molecular Muscle Experiment [8]. It is apparent from Fig. 1 that students only start to become aware of life science's relevance to space at later stages in their academic careers. Younger students who lack this awareness may be driven away from considering careers in the sector, for example, one student claimed that she had been discouraged because "[she] preferred biology more than physics/maths." With technological advances and an increasing upstream workforce comes opportunities for more frequent or more detailed scientific research in space. As well as educating younger students about the relevance of life sciences, it is important to direct university students studying relevant subjects towards these possibilities as they graduate. The survey found that these students were more unsure about how their interests related to the space sector than students studying any other degree, thus demonstrating the need for educating students about available careers within the sector.

It is also necessary to highlight that the job "rocket scientist" was named 19 times across the three surveys; 58% of these by ages 8-13. This shows a lack of space careers education, as companies do not typically hire 'rocket scientists', instead they hire a combination of engineers specialising in structures, propulsion, and systems etc. Similarly, 15 respondents gave "astrologist" as a job (two-thirds of these being age 14-18). 10 respondents were unable to name any jobs within the sector, including students studying degrees in psychology, computer science, and law, showing a complete lack of awareness of the opportunities available to them.

Although it is important to address the skills shortage within technical fields, students must be educated on non-

technical jobs in order to encourage those with non-technical skills, who are interested in space, but unaware of these opportunities available to them within the sector, to follow their interests and passions.

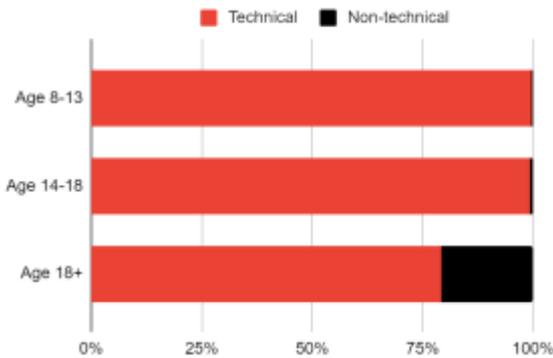


Fig. 2. The percentage of technical and non-technical roles named by students aged 8+ when asked to name 5+ jobs in the space sector (from top to bottom n=179, n=102, n=164).

When asked to list jobs within the space sector, non-technical jobs made up just 21% of all jobs given. 44% of respondents over the age of 18 were unable to name any non-technical roles, 14% of whom were studying for a non-technical degree. This was even more significant with younger students, with 98% and 99% of 14-18 year olds and 8-13 year olds, respectively, being unable to do so. This demonstrates a significant lack of awareness of potential career paths, considering the approximate 50% of non-technical roles within the sector, in turn, potentially affecting the numbers of capable graduates pursuing such careers [5]. It appears that students only become aware of these roles at a late stage in their academic career, when it is likely to be more difficult to change pathways. Many more students never learn about the opportunities available, as they falsely believe that they have studied the ‘wrong subject’ to enter the space sector. One student aged 17 claimed that “despite finding space interesting [they were] not really into the science behind it as much”, which was a recurring view among respondents, demonstrating the belief that space sector jobs are for those studying technical subjects only.

Between 2014 and 2017, business development and policy-making activities within the UK space sector saw income growth rates of 133% and 136% respectively, the second and third largest growth of all areas [1]. If this growth is to continue, individuals with the combination of both knowledge of the space sector and non-technical skills will be in even more demand. Thus, it is important to teach students that a space company runs like any other; requiring business, administration, and marketing professionals to operate, as well as the scientists and engineers who design the products. This will encourage students who had not previously considered working in the sector to apply for roles, allowing them to combine their interests and working life, and potentially build a stronger workforce.

B. Demonstrate attainability

As well as being aware of jobs in the space sector, students need to be shown that they are attainable. 18 of the students aged 8-14 surveyed, specified “NASA” when naming jobs; and 69% of university students surveyed at the National Student Space Conference, who have an assumed prior interest in space, could name fewer than 5 UK space companies off the top of their head, showing that many students are unaware of the range of opportunities available in the UK. If they are unable to identify local companies while at university, they will be unable to apply to roles or form the belief that application processes for such jobs are highly competitive. Thus, a career within the sector may seem difficult or even unattainable.

NSSC 2017 & 2018 Survey Results

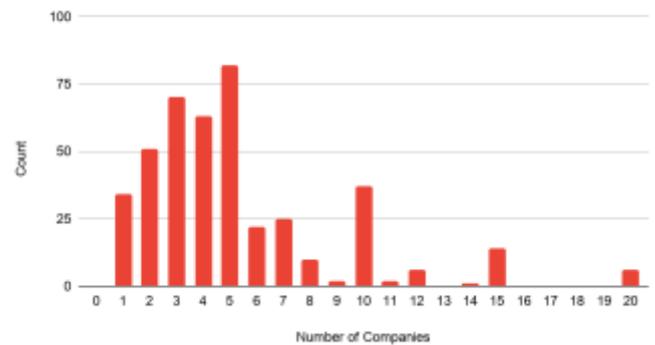


Fig. 3. Results from survey question: How many UK space companies can you name off the top of your head? (n=437).

Students also tend to perceive technical jobs within the space sector as inherently challenging. When asked, 54% of 8-14 year olds and 75% of 14-18 year olds did not think they could pursue a job within the space sector; 31% of all 14-18 year olds surveyed saying ‘it’s too hard’ or that they are ‘not good enough’ at one or more STEM subjects. 77% of the students with this view had not taken part in any space related activity, indicating that exposure can help to dispel such perceptions. This is further highlighted by Bennett et al., who found there is a stronger belief that one must be ‘clever’ to do a job in space science or technology, than in maths and science [9].

While it is true that the space industry workforce is highly-skilled, with 3 in 4 employees holding at least a primary degree, there are increasing opportunities for those who do not want to or get the grades to go to university, including various foundation year courses, distance learning courses, and apprenticeships within the space sector [1]. A 2012 analysis of technicians in the UK space industry by Lewis, highlighted a skills shortage at the technician level and in the age of the technician workforce [10]. Of 11 firms that employ manufacturing technicians, 9 expressed difficulty in hiring good talent, one describing it as their ‘biggest barrier’ to expansion. For this reason, more and more firms are starting to train apprentices. There are now over 1400 apprentices in the sector, but very few students were aware of these opportunities,

which to many, might seem more attainable than other space jobs [11].

Because they feel under-qualified, candidates are often deterred from applying for technical jobs in the first instance. They tend to be unaware that some hiring managers prioritise analytical and communication skills above specific knowledge, as they know that new recruits can gain the necessary technical skills on the job. A global study of the Information Security workforce found that 33% of cybersecurity professionals came into their role from a non-technical background (n = 19,641); in a similar way, graduates can be trained to perform roles within the space sector [12]. Students must therefore be made aware of these opportunities for development within companies, in order to encourage those who are capable to apply for roles within the sector.

C. *There is demand*

Of students aged 14 and over, 78% of those who are interested in space claimed that they have considered a job in the space sector; 84% expressed an interest in space careers resources, 23% of whom had not previously considered a career in space. Students asked for advice on potential job opportunities (37%), and applications (47%); however, only 16% believed they knew enough about jobs in the space sector to want advice on open opportunities, such as training courses and internships. Further demand can be seen by the 330,000 career-advice article views on the SpaceCareers.uk website since December 2015.

IV. HOW CAN WE EDUCATE STUDENTS ABOUT CAREERS IN SPACE?

Students can be educated about jobs in the space sector by including careers topics in both existing and new outreach and educational activities. The surveys showed a strong correlation between knowledge of jobs and those taught about in activities, indicating their impact, and the effect that modifying them could have.

Unlimited Theatre found that the percentage of students interested in becoming a scientist increased from 76% to 94% after taking part in their Astro Science Challenge, demonstrating the positive effect of outreach activities on students' career aspirations [4]. However, further reports - including ASPIRES, published by King's College London in 2013 - found that there is a lack of careers focused activities within primary schools, and suggested that they would benefit from those which promoted STEM related aspirations [13]. It is important to target this age group in particular, as students appear to develop firm views about the jobs they want to pursue at an early age. One study found that 85% of 11 year olds already knew what path they wanted to follow, very few of these involving STEM; and 80% of students in another study knew they didn't want a science based job before the age of 11 [9] [13]. Thus, outreach activities should aim to showcase the breadth of space jobs to students as young as primary school age, in order to raise awareness of them before students begin to make career choices.

Chambers, in *Starting early – the importance of career-related learning in primary school*, highlighted that hearing from professionals can be particularly effective in showing students how their studies relate to the real world [14]. This not only introduces students to careers they may not have heard of, but can lead to their increased interest in a subject, and even attainment [15]. However, of 13,000 students aged 7-11 within the study, less than 1% knew about a job from someone visiting their school. It is safe to assume that of all professionals who visit schools, the percentage of those from the space sector is low, as the space sector is significantly smaller than others. Nevertheless, the One Million Interactions programme is addressing this issue, aiming to attract more into STEM and the space industry [16].

This lack of education around careers and pathways in outreach, educational, and training activities appears to continue throughout a student's academic career. Only 19% of students aged 14-18 and 50% of students aged 18+ who have taken part in space related activities said they had learnt about the possible routes into jobs. Thus, information about potential pathways should be incorporated into these activities; one of the simplest ways being to provide follow up resources for those students who are interested. Such resources, including online interviews with professionals working in the space sector, can be found on the SpaceCareers.uk website. These provide freely available insights into specific jobs and journeys, which can be particularly useful for students who do not get access to external speakers. Careers and pathways education is especially important for students aged 14-18, as they will be in the process of making subject choices which could potentially limit future opportunities.

In addition to the SpaceCareers.uk website, UKSEDS holds Careers Launch events to showcase opportunities and career paths within the sector, through careers talks, a pathways/skills focused panel discussion, and speed mentoring (informal networking) with space professionals. 92% of attendees in 2019 agreed that the event increased their knowledge of space careers (n=72), demonstrating the effectiveness of such events. This exposure to professionals gives students the chance to explore the careers available within the sector in more depth, than online resources, as they can ask questions tailored towards the gaps in their own understanding, as well as receive more honest and detailed responses. It is recommended that this setting be used in wider events.

There is also the potential for outreach activities to focus on more non-technical jobs, showing their relevance to the space sector. This may further encourage those students who have an interest in space, but do not think they can do a 'space job', to apply their knowledge to the sector. Activities such as the Space Science and Engineering Foundation's Space Design Competitions are good as they directly expose students to a range of different jobs in the space industry, including non-technical, business aspects of the space sector. Classic space outreach activities such as building rockets or satellites could quite easily be expanded in a similar way. Students could each have a different role within their team, for example project

manager, and leads in business, engineering, science, and marketing, really bringing the project to life.

Finally, public attractions, such as museums and science centres, can play a significant part in raising students' awareness of different sectors [17]. 70% of survey respondents aged 8-13, who had taken part in some form of extracurricular space activity, claimed to have visited at least one space themed attraction. However, 33% of those students who reported visiting an attraction could only name astronaut as a space job, suggesting public attractions could do more to incorporate information about the range of available careers within the sector.

CONCLUSION

This paper has demonstrated the importance of educating students about careers within the space sector, supported by a collection of primary and secondary data, and has gone on to suggest methods to achieve this. It has shown that students lack awareness of both technical and non-technical job opportunities within the space sector, leading to the misconception that such careers are unattainable. This can be overcome by educating students through outreach activities, such as talks from professionals, interactive workshops, and online resources. By improving the methods of educating students about careers in the space sector, an increased number of capable applicants will be encouraged to consider technical roles, enabling the UK to reach the goals set out by the UK Space Agency; and those with non-technical skills, and an interest in the sector, may be shown how they can pursue a space-related career.

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