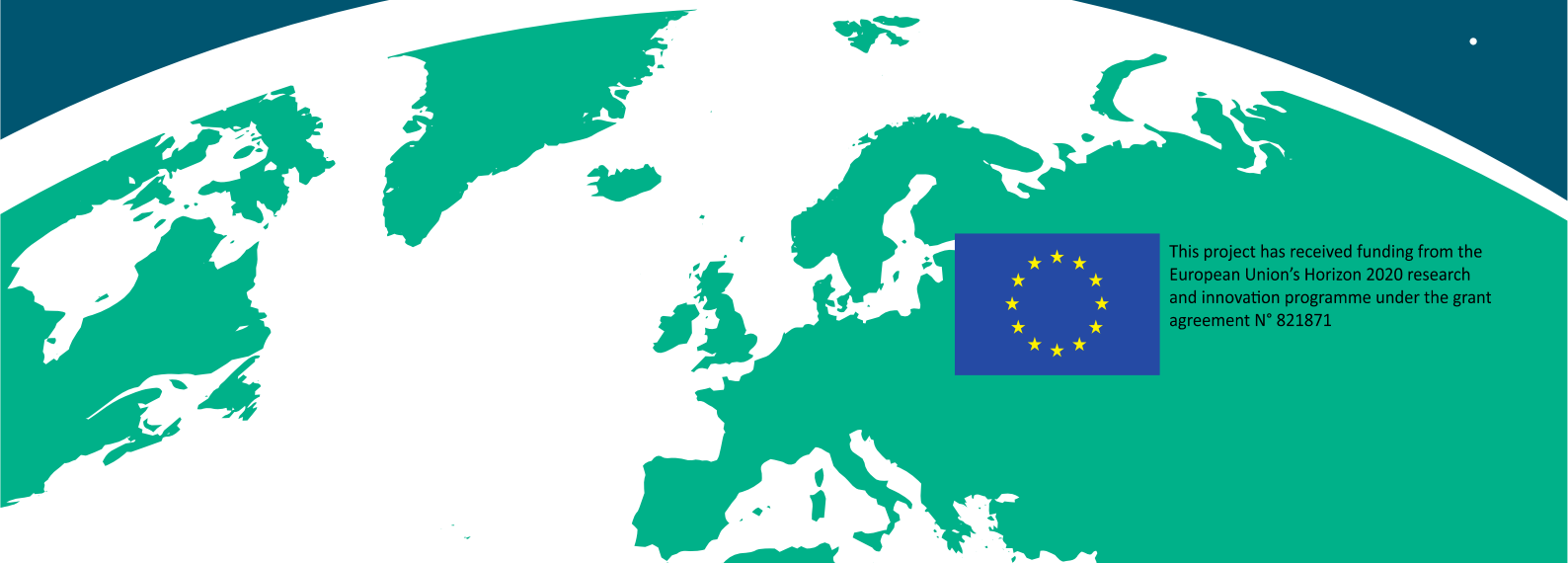
FINAL EVALUATION REPORT

DELIVERABLE N.5.3



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement N° 821871

DELIVERABLE DESCRIPTION

This deliverable describes the total evaluation data collected throughout the duration of the Our Space Our Future delivery programme. This deliverable provides statistical comparisons of students' attitudes before and after engaging with Our Space Our Future, detailed case studies of impact, the impact of Our Space Our Future activities on teachers' attitudes and classroom practice as well as contextual feedback from public audiences around their online engagement and community event participation.

Deliverable:	**5.3**
Work Package:	**5**
Due of Deliverable:	**31 May 2022**
Lead beneficiary of this deliverable:	**Cardiff University**
Version:	**1**
Author(s) and Institution(s):	**Sophie Bartlett, Cardiff University**
Submission Date:	**31st May 2022**
Reviewers:	**Jen DeWitt (external consultant)** **Lisbeth Kristine Olesen Walakira, Planetarium and Kevin Ramirez EIT Climate-KIC**

Project co-funded by the European Commission within the H2020 Programme (2014-2020)

PU	Public	**X**
CO	Confidential, only for members of the consortium (including the Commission Services)	
CI	Classified, as referred to in Commission Decision 2001/844/EC	

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 821871"

TABLE OF CONTENTS

ABBREVIATIONS

Acronyms	Explanation
STEM	Science, Technology, Engineering, and Mathematics
SEND	Special Educational Needs and Disabilities
ED	Explorer Dome – England Delivery Partner
NUC	Nuclio – Portugal Delivery Partner
PDK	Planetarium – Denmark Delivery Partner
PSC	Psiquadro – Italy Delivery Partner
SMS	Science Made Simple – Wales Delivery Partner
GLO	Generic Learning Outcome
SD/D, NE, SA/A	Strongly Disagree/Disagree, Neither, Strongly Agree/Agree
CPD	Continued Professional Development

KEY HEADLINES

- Our Space Our Future achieved or partially achieved 19 out of 21 Generic Learning Outcomes.
- Following the implementation of Our Space Our Future, 85.8% of students agreed or strongly agreed that 'space science is interesting'.
- Following the implementation of Our Space Our Future, 85.3% of students agreed or strongly agreed that people from different countries work in space science.
- Following the implementation of Our Space Our Future, 81.0% of students agreed or strongly agreed that discoveries in space science are important to society.
- Following the implementation of Our Space Our Future, the majority of students still do not aspire to a career in the space science industry.
- The Our Space Our Future interventions were successful in narrowing the gap in differences in attitudes among male and female students.
- Active participation and autonomy are crucial to positive learning experiences in science and STEM.
- A large area of impact was seen in promoting students' recognition of the diversity of the space industry and the variety of possible career pathways.
- A career in the space industry is perceived by many students as a daunting career path that is dangerous, high pressured, and requires you to be away from your family.
- Tailoring interventions to students' specific interests and introducing them to industry professionals who are personable and 'like them' can help students perceive the space industry as a desirable and realistic career pathway.
- Framing science as a process of asking questions rather than always having the answer get help students to feel empowered to do science and STEM.
- Over 90% of teachers agreed or strongly agreed that the Our Space Our Future continued professional development (CPD) content would benefit their

students, was inspiring, will be useful in their teaching and in engaging their students.

- Over 90% of teachers reported that they would share their learning from Our Space Our Future with their colleagues.

- Having completed the Our Space Our Future CPD session, teachers intended to include space-related classroom activities more frequently and promote the diversity of job opportunities in the space industry to their students.

- Public audiences enjoyed being active participants with the opportunity to engage in a variety of hands-on activities.

- Parents expressed their enjoyment and appreciation of observing their child's participation and learning about the work they had been doing with Our Space Our Future.

- Public audiences indicated that they would like to continue their engagement with space-related activities in the future.

Successes and Challenges

There were a number of key successes and challenges that accompanied the implementation of the Our Space Our Future programme. These are summarised below:

Key successes of Our Space Our Future:

- Multiple interventions with meant audiences built relationships with delivery partners and felt a greater sense of belonging
- Successful engagement with diverse schools with underserved status
- An inclusive approach meant that interventions were successful in narrowing the gender gap in students' attitudes towards space science
- The adaptability of delivery partners in the face of the pandemic (shifting timelines, moving to online delivery)
- High quality content developed by delivery partners and informed by: literature review (D2.1), engagement with international stakeholder group, engagement with teachers, discussions among delivery partners
- Involvement of real-life role models in delivery and student interactions

Key challenges of Our Space Our Future:

- The onset of the Covid-19 pandemic and consequential social distancing regulations, school closures and business closures

- Changes to implementation and delivery of interventions and well as timelines
- Variability in implementation methods and techniques across partners made standardisation of Our Space Our Future approach difficult
- Difficulty involving family and community in events due to social distancing regulations
- Varied willingness and flexibility among schools – other priorities and limited teaching time

INTRODUCTION

The Our Space Our Future Project

Europe is facing an ongoing deficit in terms of the level of qualified personnel with sufficient skills in Science, Technology, Engineering, and Mathematics (STEM), including Space Science, that are demanded by today's rapidly evolving technological society. Although citizens recognise that science and technology are important for society to thrive (European Commission, 2021), and many school students enjoy such subjects, these perceptions do not appear to translate into career aspirations, and sadly, many school students perceive such careers to be uninspiring (Ametller and Ryder, 2014; Archer et al., 2013). Arguably even more concerning is that many, even high-achieving students, have a perception of being 'not good enough' and regard such careers as unattainable (Horizons in Physics Education, 2016; Rodd et al., 2014).

Students' and young peoples' attitudes towards science, technology, engineering and mathematics (STEM) have been a topic of research for several decades. Research has focused on various dimensions of individuals' attitudes, such as their general interest and enjoyment of the subjects (Osborne, Simon and Collins, 2003; Sjøberg and Schreiner, 2010), how they perceive the subjects' relevance both on a personal level and wider global scale (Cleaves, 2005; OECD, 2006), and individuals' own identities in STEM (Archer et al., 2010; Dawson et al., 2019). Research has also explored students' attitudes towards more specific topics within STEM, often aligning with scientific developments. Examples of such include students' attitudes towards climate science (Lee at al. 2020), technology (Ardies et al., 2014) and also, space science and exploration (DeWitt and Bultitude, 2018; Jones et al., 2007).

What is consistent among science-related subjects, is students' apparent interest and recognition of the relevance and importance of such subjects, but a lack of aspiration and identity in pursuing related careers (Ametller and Ryder, 2014; Archer et al., 2013; Jenkins and Nelson, 2005). This is particularly alarming given the ongoing deficit Europe is facing in terms of qualified personnel with appropriate STEM skills to match the demands of a rapidly evolving technological society (CEDEFOP, 2014; Murray, 2016).

The Our Space Our Future project set out with a mission to shift perceptions among students and guide them towards perceiving careers within the space science industry as an inspiring, achievable reality for all individuals, regardless of gender, attainment or socio-economic background.

The Our Space Our Future project engaged with students, teachers and families across five European countries: Denmark, England, Italy, Portugal and Wales, delivering a variety of informal science experiences that brought together industry role models, students, parents and teachers. Our Space Our Future set out to encourage young people to regard individuals working within the space industry as 'someone like me', (Barton et al., 2017; Muller et al., 2013) and perceive career pathways in the space industry as inspiring and realistic avenues for their future.

The impact of the Covid-19 global pandemic was not insignificant to the Our Space Our Future project. School closures, shifts to remote learning, and social distancing regulations meant that the format of interventions had to be adapted, and as such, the evaluation strategy had to adapt in parallel.

In September 2021, the evaluation framework and methods were reviewed, and additional measures were put in place to capture contextual data that would highlight the delivery adaptions among individual delivery partners, and to ensure that any additional or unintended outcomes were captured.

Each delivery partner was required to capture data that could create a case study example of their student interventions. A single school or class from each country acted as a case study and data was captured via a focus group discussion with a sample of students. Delivery partners were also required to provide detailed descriptions and observations on the interventions these students had engaged in. Partner feedback forms captured the four unique interventions students engaged in: what worked well, what did not, and lessons learns through partners' experiences. The partners were well placed to provide this information as they had engaged with the students and teachers over a prolonged time period and had first-hand observations of the interventions in action.

Focus groups with students allowed us to gather more contextualised data about students' experiences, what they did and did not engage with, and how they felt when participating in the Our Space Our Future interventions. This was complementary to the broader data provided in the students' quantitative survey responses. The combination of quantitative and qualitative data therefore permitted a more holistic understanding of participants' experiences and perceptions and also allowed us to explore the impact of online and in-person implementations.

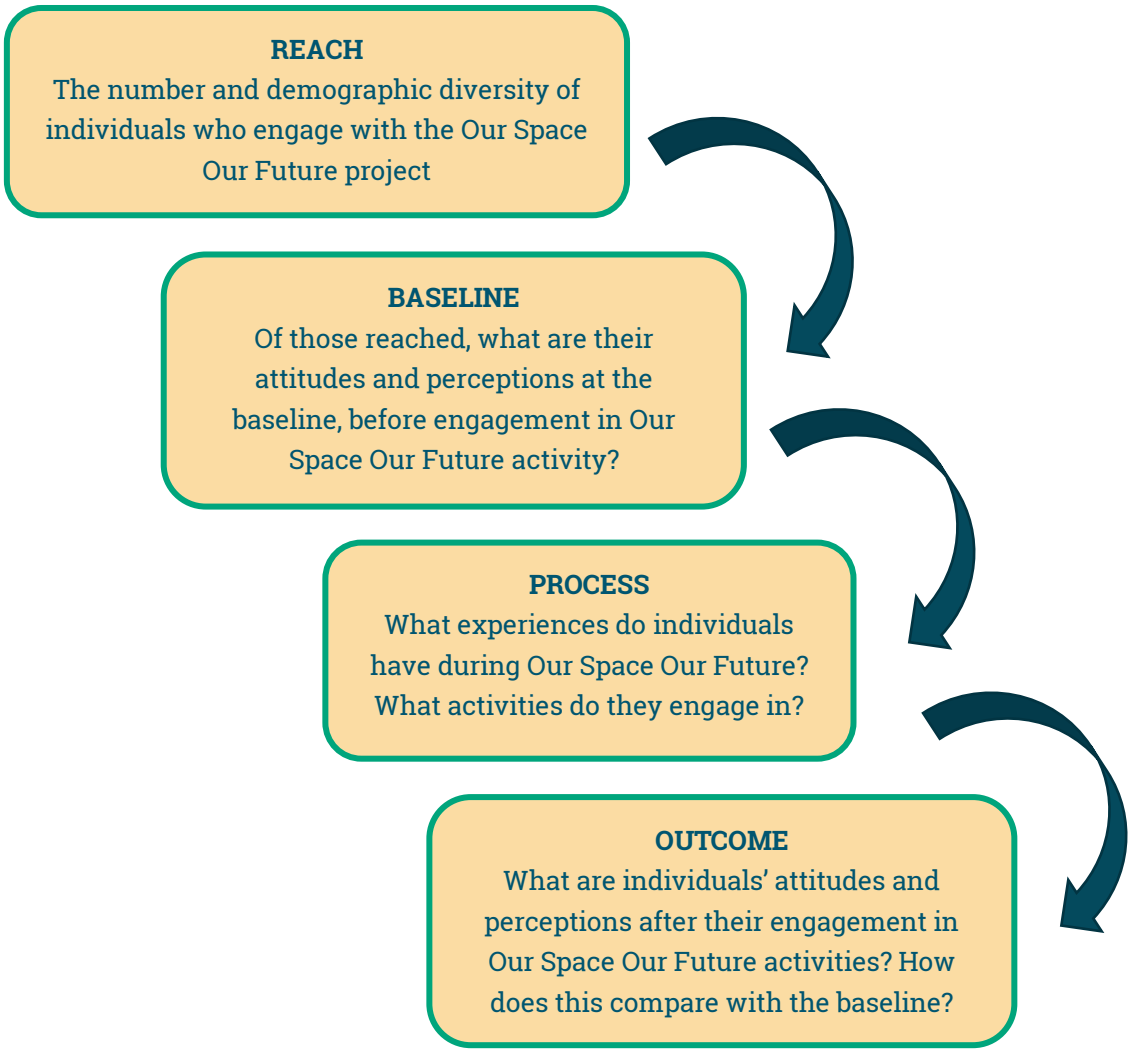
As a result of the pandemic and subsequent cancellation of many in-person events, Our Space Our Future increased its online presence. This has included webinars, competitions, social media events and other online engagement events. To assess the impact of this online presence, we collected evaluation data from our online

public audience to explore their perceptions and experiences of these engagements. This has included social media data collection via short questions or polls and a post-webinar feedback survey.

Aim of Deliverable

This report details the evaluation results that were obtained for student, teacher and public audiences across the five delivery partners within Our Space Our Future. Other deliverables within this work package include Deliverable 5.1 that set out the evaluation framework and strategy for Our Space Our Future, and Deliverable 5.2 that provided detailed information around the attitudes and perceptions of the student audience at the baseline and before any interventions had taken place. Deliverable 5.3 now provides a full picture of the impact of the Our Space Our Future programme on its audience, including baseline and post-intervention data and covering all four processes shown in Figure 1.

Figure 1 – Structural Process of Measuring Impact



METHOD

The Our Space Our Future Evaluation Framework

Given the clear mission and objectives of the Our Space Our Future project, it was crucial to ensure the project was sufficiently evaluated in terms of its success and the extent of its impact. As such, an evaluation framework was embedded within all Our Space Our Future activities to gain a holistic perspective of the impact on our audience groups. This evaluation framework is set out in detail in Deliverable 5.1 – Evaluation Framework. The specific objectives of the Our Space Our Future evaluation were threefold, based on the three primary audience groups:

1. To evaluate the impact of Our Space Our Future interventions on students' **attitudes** towards space science in five key areas: **interest, relevance, accessibility, possible selves** and **future aspirations**
2. To evaluate the impact of Our Space Our Future interventions on **teachers' attitudes and classroom practice**
3. To gain contextual feedback on **public experience** and **participation** at community events

These three overarching objectives were used to guide the Our Space Our Future Generic Learning Outcomes. The Generic Learning Outcomes (GLO) framework was originally developed at the University of Leicester and has been widely adopted for informal learning initiatives (Dodd, 2009). The Generic Learning Outcomes were built into the foundation of the Our Space Our Future evaluation strategy and framework that is described in full in Deliverable 5.1.

The data described in this report was captured from three participant groups and via a number of different methods. The participant groups, point of data collection and method of data collection is summarised in Table 1.

Table 1 – Participant Groups and Evaluation Data Collection

Participant Group	Time of Data Collection	Data Collection Instruments
Students	Pre-Intervention Post-Intervention	Surveys Focus Groups
Teachers	Post-Intervention Follow-up	Surveys
Public	During Interventions Post-Interventions	Graffiti Walls Mentimeter Post-Webinar Surveys

The data collection instruments are set out in Deliverable 5.1 and so are not reported again here.

Reporting

Evaluation results are reported according to each of the three participant groups. We begin with results from student evaluation, followed by teachers, and finally, our public audience.

As anticipated, additional baseline data was collected subsequent to the submission of Deliverable 5.2. The delay in data collection was a result of postponed school engagement due to the Covid-19 pandemic and school closures. As described in Deliverable 5.2, baseline data collection had two main objectives:

1. To identify a benchmark of the attitudes among the Our Space Our Future student audience
2. To permit comparisons when parallel data is collection after all Our Space Our Future interventions have been implemented.

The student results section therefore begins with an overview of the full baseline dataset in order to address the first point and 'set the scene' for the attitudes and perspectives of students, before any interventions took place. Having now completed post-intervention data collection, this report will also address the second point, and perform comparisons between the two data collection points, thus capturing the impact of Our Space Our Future on its student audience.

Following the high level analysis of the quantitative baseline and post-intervention data, results in terms of the Our Space Our Future evaluation strategy and five attitudinal constructs are discussed. These sections focus on the student cohort as a whole. Following these, results are discussed in terms of gender and country/delivery partner to explore similarities and/or differences across these student groups.

Following discussion of the student results, data captured from teachers who attended the Our Space Our Future continued professional development (CPD) events are explored to identify the value of the CPD events to these individuals and if and how they intend to use Our Space Our Future in their teaching practices. The final results section focuses on our public audiences who attended community events or Our Space Our Future webinars.

Throughout this report, both quantitative and qualitative data are detailed in order to provide a holistic picture of our audiences' feedback and experiences. Where

relevant, focused examples of implementation scenarios or findings have been used to provide additional context. These examples are provided in four formats:

Point of Impact are used to highlight examples of where substantial evidence has been collected in a particular area

Remaining Challenges focus on the challenges that remain following interventions and where further work is needed

Intervention Case Studies provide summaries of student interventions in a particular school or country

Community Event Case Studies provide summaries of community events that took place in a particular country

Each participant group had their own evaluation objectives and generic learning outcomes (GLO). Table 2 provides a summary of the GLOs for each participant group and where relevant evidence is reported throughout this report.

It is important to note that this table is not intended to highlight whether or not these GLOs were achieved, but to indicate where the relevant evidence is reported. Whether GLOs were met is reported throughout the report and summarised in Table 19 in the Conclusion of this report. GLOs are numbered and labelled by each participant group (S=student, T=teacher, P=public).

Table 2 – Summary of Generic Learning Outcomes and Related Evidence

GLO	Description	Related Evidence
Enjoyment, Inspiration and Creativity	S1: Students feel greater enjoyment when doing science	Interest
	S2: Students enjoy learning about space science	Interest
	T1: Teachers find the OurSpace CPD content inspiring	Usefulness of CPD
	T2: Teachers find the OurSpace CPD sessions useful to their classroom practice	Usefulness of CPD
	P1: Members of the public enjoy the OurSpace community events	Community Event Audience Feedback
Attitudes and Values	S3: Students perceive space science to be accessible to them	Possible Selves
	T3: Teachers feel that the CPD content engages their students	Usefulness of CPD
	T4: Teachers regard space science as applicable to all students	Applicability to Diverse Student Groups
Behaviour and Progression	S4: Students want to learn more about space science	Interest
	S5: Students want to learn more about careers in space science	Future Aspirations
	S6: Students consider pursuing a career in space science	Future Aspirations
	T5: Teachers bring space science into their classroom	No Evidence
	T6: Teachers use the strategies they learnt in the CPD in their classroom	No Evidence
	T7: Teachers inform students of career opportunities in space science	No Evidence
	T8: Teachers are encouraged to promote a more student-centred classroom	Intentions Beyond the CPD Event
	P2: Members of the public engage in conversations with students and ask questions about their work	Community Event Audience Feedback
Knowledge and Understanding	S7: Students understand the importance and value of space science in society	Relevance
	S8: Students recognise the diversity of people who work in the space industry	Accessibility
	S9: Students recognise the relevance of space science to environmental issues	Relevance
	T9: Teachers know how to apply space science as a context in the science classroom	Intentions Beyond the CPD Event
	T10: Teachers understand how space science can be applied to their classroom through real-life examples	Intentions Beyond the CPD Event

STUDENT RESULTS

Students were the main audience group for Our Space Our Future and therefore where our evaluation methods were most heavily focussed. Before discussing the results from the student data collection, it is important to note that for the student survey, upon review of the results, it was evident that the statements 'important discoveries in space science have been made by men' and 'important discoveries in space science have been made by women' were problematic. These statements were intended to explore the accessibility of the space industry and who students perceived to work in the industry. However, due to the layout of the survey, students would see one statement before the other. Where paper-copies of the survey were completed, some students left comments indicating the statement should refer to 'people' or that the statements were sexist. It was also clear that some students went back and changed their answer after seeing that there was a statement for 'men' and 'women'. However, it was unclear whether some students were responding to the survey based on their feeling towards the insinuation of the statements, rather than the statements themselves. The two statements were therefore discounted from analysis.

Overview of Baseline versus Post-Intervention

Following the completion of data collection, the Our Space Our Future project obtained baseline data from 2966 students from 50 schools across the five consortium countries. Following the Our Space Our Future interventions, we captured post-data from 1380 students from 38 schools across the five consortium countries. These numbers are summarised according to each delivery partner in Table 3.

Table 3 – Pre and Post Data Collection across Delivery Partners

Delivery Partner (Country)	Pre-Surveys: No. Students (No. Schools)	Post-Surveys: No. Students (No. Schools)
Planetarium (Denmark)	598 (12)	269 (10)
Explorer Dome (England)	550 (6)	273 (5)
Psiquadro (Italy)	515 (10)	148 (6)
Nuclio (Portgual)	736 (15)	500 (11)
Science Made Simple (Wales)	567 (7)	190 (6)
Total	**2966 (50)**	**1380 (38)**

In total, 4741 students engaged with the Our Space Our Future interventions, this equates to a response rate of 62.6% at baseline and 29.1% post-intervention. This reduction in response rate was expected and largely due to restrictions in schools due to the pandemic and their loss of teaching time which meant teachers and students were very limited in their time. Furthermore, relationships between schools and delivery partners were often remote (online interactions) which created additional difficulties in implementing the evaluation surveys.

The gender of students was obtained through an open-response question. Both baseline and post-intervention data provided a **relatively equal representation of male and female students**. At baseline 52% of students indicate they were male and 46% indicated they were female. In the post-intervention survey, 53% students indicated they were male and 45% female. On both occasions approximately 1% of students identified as neither male or female genders, although we acknowledge that individuals who do not identify as male or female do not form a homogenous group, the small proportion of responses that were not male or female meant that no meaningful sub-analyses were possible, and therefore male and female genders take focus in this report. Some students also left the question blank or wrote that they 'prefer not to say'.

The age of students ranged from aged 9 to 17+ with the majority (77.1%) being aged 11-13 when baseline data was collected. Given that more than a year had passed by the time post-intervention data was collected, the student cohort was older, and the majority (81.9%) were aged 12-14.

The student cohort included individuals from a number of underserved groups, most commonly, **delivery partners were engaging with students from less privileged socio-economic backgrounds** (compared to national averages), **lower average grade levels** (compared to national averages) and/or with **special educational needs or disabilities,** and **high student absences** from school. Table 4 provides a summary of the number of schools in each country that deviated negatively from the national average for particular categories. For example, Denmark engaged with 11 schools where the leven of student absences was above the national average, and Wales engaged with six schools whose average attainment was below the national average.

Table 4 – Summary of Underserved Schools and Categories by Country

Underserved Category	Denmark (PDK)	England (ED)	Italy (PSC)	Portugal (NUC)	Wales (SMS)
Special Educational Needs or Disabilities (SEND)	1	5	5	3	
Student Absence	11	3			5
Low Socio-Economic Status		6	1	2	6

Geography (rural/urban)		3			
Race and Ethnicity		2			
Language		1	1		
Attainment	10	5			6
Continuation into higher education	9				
Parents' completion of compulsory education				5	

At the baseline, students as a collective appeared to hold generally positive attitudes towards space science. **More than three quarters of students reported finding space science interesting, recognised space as a global industry and viewed space as important to society**. Nonetheless, students were less positive towards the idea of pursuing a career in the space science industry. Our data revealed that less than a quarter of students agreed or strongly agreed that they would like to work in the space industry or have a job related to space. Such findings echo existing literature that argues **interest is not enough to translate into career aspirations** (Archer et al. 2020; DeWitt and Bultitude, 2018).

Chi-square cross-tabulations on baseline data demonstrated significant differences ($p \leq 0.05$) in attitudes across particular demographics. **Significant differences were evident between male and female students** for 12 out of the 14 statements. The two exceptions were the statements: 'people from different countries work in space science' and 'I could work in the space science industry when I grow up if I wanted to'. Generally, **male students held more positive attitudes than female students**. Female students gave more positive responses than male students for three statements, these were: 'discoveries in space science are important to society', 'discoveries in space science help the environment' and 'all kinds of different people work in the space science industry'. Effect sizes (Cohen, 1988) in gender differences ranged from 0.051 (small) for the statement 'discoveries in space science are important to society', to 0.147 (small) for the statement 'I would like to have a job related to space science'.

Chi-square cross-tabulations of baseline data demonstrated **significant differences ($p \leq 0.05$) between countries** for all statements. Effect sizes were small, ranging from 0.086 (small) to 0.400 (small). The smallest effect size (0.086) was obtained for the statement 'people from different countries work in space science', the proportion of students who agreed or strongly agreed with this statement ranged from 72.1% (Denmark) to 86.2% (Italy), providing a range of 14.1%.

The largest effect size (0.400) was seen for the statement 'all kinds of different people work in the space science industry', where the proportion of students who

agreed or strongly agreed with this statement ranged from just 21.5% (Italy) to 83.2% (Wales), providing a range of 61.5% (see Table 5). When looking at country comparisons, it is of interest that of all the statements, students in Italy provided the least agreement with this statement, and students in Wales, provided the highest agreement with this statement (see Table 5).

More broadly, from Table 5, it is evident that students from Denmark gave the highest proportion of positive responses to one statement, England to no statements, Italy to six statements, Portugal to five statements and Wales to two statements.

Table 5 – Baseline Student Survey Results by Country / Delivery Partner

Statement	Denmark (PDK)	England (ED)	Italy (PSC)	Portugal (NUC)	Wales (SMS)
Space science is interesting	57.8%	60.9%	**91.1%**	87.8%	66.0%
Discoveries in space science are important to society*	67.9%	64.7%	88.2%	**90.7%**	75.3%
People from different countries work in space science	72.1%	77.9%	**86.2%**	73.0%	76.9%
I could work in the space science industry when I grow up if I wanted to*	39.2%	38.9%	40.1%	28.7%	**43.9%**
All kinds of different people work in the space science industry*	59.1%	80.1%	21.5%	50.6%	**83.2%**
I enjoy learning about space science*	57.8%	52.7%	69.6%	**82.8%**	64.8%
I would like to find out more about jobs in the space science industry	43.5%	36.8%	69.9%	**71.6%**	45.1%
I would like to work in the space science industry*	11.4%	17.0%	**36.2%**	25.0%	18.5%
I am clever enough to work in the space science industry	**47.6%**	25.7%	27.2%	30.1%	22.2%
Discoveries in the space science help the environment	42.9%	58.6%	71.1%	**76.0%**	63.5%
I would like to have a job related to space science	14.3%	17.3%	**35.3%**	31.8%	16.2%
Discoveries in space science make our lives easier	30.6%	39.1%	50.8%	**68.0%**	37.9%
I could develop the skills needed to work in the space science industry	27.9%	47.4%	**53.9%**	49.9%	27.9%
I would like to learn more about space science	69.8%	54.4%	**84.5%**	78.5%	64.7%

*Statements that were included in the Special Educational Needs and Disabilities (SEND) version of the student survey

From the baseline data collection, it was apparent that before the Our Space Our Future interventions, students appeared to hold generally positive attitudes towards their interest in space science, its position as a global industry and one that

is important to society. Students were less positive towards the idea of pursuing a career in the space science. Analyses demonstrated significant attitudinal differences across certain demographics. Generally, **male students held more positive attitudes** than female students. Although differences in attitudes across countries were implied, there was insufficient data to run statistical comparisons by country.

Given the results of students' attitudes at the baseline, Our Space Our Future was devoted to **improving students' aspirations towards careers in the space industry and their sense of empowerment in pursuing such careers.** We also hoped to **narrow the gap between perceptions among male and female students**. Where positive attitudes existed around students' interest and views around the relevance of space science, we sought to foster these perceptions and encourage students to expand their interest and understanding.

In terms of how students' attitudes changed following the Our Space Our Future multiple interventions, we saw a **positive change in 12 out of the total 14 statements**. That is, students gave more favourable responses to 12 statements, after experiencing the Our Space Our Future interventions. For two statements, students provided marginally more negative responses following the interventions. These results are summarised in Table 6 where statements are ordered according to the largest change between pre- and post-measurement, and the red line illustrates the cut off where students provided more negative responses on the post-survey.

The distribution of students responses to each of these statements in pre- and post-surveys are presented in full in Appendix 1.

Table 6 – Comparison of Students' Survey Responses Pre- and Post-Interventions

Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change
Discoveries in space science make our lives easier	49.7%	63.3%	+13.6%
All kinds of different people work in the space science industry*	59.1%	69.3%	+10.2%
Space science is interesting	76.7%	85.8%	+9.1%
I enjoy learning about space science*	66.1%	74.2%	+8.1%
People from different countries work in space science	77.9%	85.3%	+7.4%
Discoveries in space science help the environment	67.1%	71.4%	+4.3%

I am clever enough to work in the space science industry	27.1%	31.2%	+4.1%
Discoveries in space science are important to society*	77.6%	81.0%	+3.4%
I would like to find out more about jobs in the space science industry	56.7%	58.6%	+1.9%
I would like to have a job related to space science	25.3%	27.1%	+1.8%
I could develop the skills needed to work in the space science industry	49.3%	50.9%	+1.6%
I would like to learn more about space science	70.8%	71.6%	+0.8%
I would like to work in the space science industry*	21.4%	21.1%	-0.3%
I could work in the space science industry when I grow up if I wanted to*	37.8%	36.2%	-1.6%

*Statements that were included in the SEND version of the student survey

An increase in the proportion of students with positive attitudes for 12 out of the 14 statements is an incredibly encouraging result for Our Space Our Future. **Two statements yielded increases of 10% or more, and five statements yielded an increase of 5% or more**. Nonetheless, it is disheartening that the statements towards the bottom of Table 5 show that **little change was seen related to students' career aspirations and sense of empowerment to pursue careers in the space industry.**

An important consideration of these results and one the emphasises the merit of the positive changes, is the time period that had elapsed between pre and post data collection. Given the multiple intervention approach of Our Space Our Future and delays due to the pandemic, **more than a year had passed between when students completed the baseline survey and when they completed the post-interventions survey**. On occasions where where data is captured immediately before and immediately after a novel, one-off event, it can be hard to disentangle short-term excitement and enthusiasm among participants from actual attitudinal change. However, given the extended time period between the baseline and post data collection in Our Space Our Future, any short-term excitement based on sheer novelty of an event would have diminished. As a result, **we can be more confident that these results indicate actual, long-term attitudinal change.**

The remainder of this results section explores this data in greater detail. Qualitative data from students, teachers and delivery partners is explored in order to provide further context to students' experiences during the Our Space Our Future intervention and provide valuable explanations behind the quantitative findings.

Results by Attitudinal Area

The following sections are structured around the five attitudinal constructs that comprised the Our Space Our Future evaluation strategy:

- Interest – is space science interesting?
- Relevance – is space science important to their own life and society in general?
- Accessibility – who works in space science?
- Possible Selves – could they themselves be a space employee?
- Future Aspirations – do they intend to pursue space science in the future?

Each of these constructs map directly to the Our Space Our Future Generic Learning Outcomes (GLOs) for students. The data relating to each of the five attitudinal constructs is discussed, and the extent to which the student GLOs were achieved is described.

Interest

The interest component of our student evaluation was intended to explore whether students perceive space to be an interesting and engaging topic that they enjoy learning about. This attitudinal area of investigation therefore relates to the following three GLOs of Our Space Our Future:

- S1: Students feel greater enjoyment when doing science
- S2: Students enjoy learning about space science
- S4: Students want to learn more about space science

Baseline data revealed generally positive attitudes among the Our Space Our Future student cohort towards space science, before any interventions had taken place. However, data from post-intervention surveys indicated that Our Space Our Future successfully increased the level of positive attitudes, and decreased the level of uncertainty (i.e. students who neither agreed or disagreed with statements) among students towards space science in terms of interest and enjoyment.

The proportion of students who agreed or strongly agreed with the statements, 'space science is interesting' and 'I enjoy learning about space science' increased by 9.1% and 8.1% respectively, from the baseline survey to after the Our Space Our Future interventions. These changes are highlighted in Table 7.

Table 7 – Students' agreement with 'Interest' statements, pre- and post-interventions

Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change
Space science is interesting	76.7%	85.8%	+9.1%
I enjoy learning about space science	66.1%	74.2%	+8.1%

In focus group discussions, reasons for this increase in interest and enjoyment were implied in students reflections on what they liked most about Our Space Our Future. Students often commented on the new learning they acquired and how the sessions were "*informative*":

[I liked] just flying through space in the Explorer Dome… seeing loads of stuff and learning about everything in space (Male Student, England)

I think it was funny and exciting and I learnt a lot (Male Student, Denmark)

I liked most the work in which we did the questionnaire [intervention activity, not evaluation] because there was a lot of information there that people didn't know and when they answered, maybe they got to know more (Male Student, Portugal)

In the context of how the Our Space Our Future interventions compared to students' 'normal', day-to-day science lessons at school, students expressed how they found the Our Space Our Future interventions to be preferable over their day-to-day science lessons:

Our Space was much better (Male Student, Wales)

However, in the context of the implications of this, and how such information could inform future education programmes and interventions, it was important to understand more about why students found the Our Space Our Future interventions to be "*much better*" than their typical science lessons. Students' reflections were indicative that they found the Our Space Our Future activities to be "*different*" to their typical science lessons, providing more novel learning experiences:

It was fun because it was something different, it wasn't just a lesson (Male Student, Portugal)

We don't have science classes like that (Male Student, Portugal)

Students perceived the Our Space Our Future activities to be more exciting and captivating, even for the more disengaged students:

The whole project was given with more emotion, captivating more students to learn… arousing some interest even to the most disinterested students (Male Student, Portugal)

In particular, the Our Space Our Future activities involved more experiments and discussions, and less copying from the board:

There was a lot of science experiments (Male Student, Wales)

We usually just copy stuff off the board (Female Student, England)

The project has been a little funnier than here at school, because here we must read a lot and we don't do so many exciting experiments (Male Student, Denmark)

I learn to engage myself with Space in general. At school, we do not discuss this a lot (Female Student, Italy)

These reflections from students are evidence to suggest that GLOs S1: students feel greater enjoyment when doing science and S2: students enjoy learning about science were achieved whilst engaging with Our Space Our Future. The shift from copying from the board to active discussions and experiments, meant that students felt more actively involvement in their learning, rather than being passive observers. This key finding is summarised in Point of Impact #1.

POINT OF IMPACT #1

Students' Active Participation in their Learning

Findings from our Literature Review (D2.1) yielded the recommendation that in order to develop students' science identity we need to steer away from didactic delivery of facts in science and move towards a practical approach, involving hands-on activities.

Feedback from students following the Our Space Our Future interventions demonstrated the importance of enabling students' involvement in science. When asked about what they had enjoyed most about the Our Space Our Future project, students appreciated the autonomy of doing their own practical experiments and presentations. Not only did students reflect that their involvement was beneficial to their enjoyment:

"When you [presenter] do experiments it's boring, but if we do them, it's more fun" (Male Student, Denmark)

"I've enjoyed it because it's entertaining, you get to join in in fun activities, you get to participate and it just makes you happy" (Female Student, Wales)

"We got to go in our own groups and just do our own research about what were going to talk about in our presentations, so that was fun, and doing research together" (Male Student, England)

"I really like the practical side, I don't really like watching people do something. I like doing it myself" (Female Student, England)

But some students in Wales explained how their involvement was also beneficial to their learning:

"I learn better when I actually do things" (Male Student, Wales)

"I'm more of a physical learner so I like it when I can be joined in" (Female Student, Wales)

In terms of interest in taking their learning further, the statement 'I would like to learn more about space science' was relatively unchanged between pre- (70.8% agreement) and post-interventions (71.6% agreement), with an increase of just 0.8%. Although no real change was observed, the high proportion of students agreeing with this statement at the baseline, meant there was little room for growth or improvement. Nonetheless, it is encouraging to see that this interest was sustained following the interventions, and **students' appetite to learn more remained**, and therefore GLO S4: students want to learn more about space science appears to have been achieved.

It was also promising to see pockets of evidence to suggest that some students had been highly motivated by the Our Space Our Future interventions and had pursued further learning following their involvement. One teacher in England provided the following commentary:

> *We have got some kids who have expressed interest in learning more. So, there's a group of students who binge Kurzgesagt* videos and they are continuously looking at quantum mechanics and what would happen if we nuked the moon? You know, they have just taken the space thing and just gone with it in different directions. We've also got two who have picked up computer simulators for rocket launches. Because that was the thing we introduced for the modelling for the rocket launchers, and they've got totally obsessed with that.* (Secondary School Science Teacher, Male, England)

*Kurzgesagt means 'in a nutshell' in German. It is a website that creates informative animations around an array of topics: https://kurzgesagt.org

Students' interest was an area of positive impact for Our Space Our Future. Although students indicated relatively high levels of interest in topics of space in the baseline data, it is apparent that this interest increased following the Our Space Our Future interventions. Students were also forthcoming in expressing their favour of the Our Space Our Future interventions over their day-to-day science lessons and reflected that this was largely due to their active participation in their learning.

The data discussed in this section is evidence that the following three GLOs were achieved:

- S1: Students feel greater enjoyment when doing science
- S2: Students enjoy learning about space science
- S4: Students want to learn more about space science

Relevance

The relevance component of student attitude measurements was designed to explore students' perception of the relevance and value of space science to their own lives and to society. This area therefore corresponds to the following two GLOs:

- S7: Students understand the importance and value of space science in society
- S9: Students recognise the relevance of space science to environment issues

Students' perception of the relevance of space science was captured through the three statements listed in Table 8. The statement relating to the importance of space science to society was one of the more positively received statements at the baseline, where over three quarters (77.6%) of students agreed or strongly agreed that discoveries in space science are important to society. At this point, students were also relatively positive about discoveries in space science helping the environment (67.1% agreed or strongly agreed). However, students were less positive about whether discoveries in space science 'make our lives easier' where approximatel half (49.7%) of students agreed or strongly agreed with this at the baseline and 41.9% neither agreed nor disagreed. However, following the Our Space Our Future interventions, it was this statement that saw the greatest increase in positive responses out of all 14 statements, with a rise of 13.6% in the proportion of students who agreed or strongly agreed.

Changes in students' responses to these three statements between pre- and post-intervention are summarised in Table 8.

Table 8 – Students' agreement with 'Relevance' statements, pre- and post-interventions

Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change
Discoveries in space science are important to society	77.6%	81.0%	+3.4%
Discoveries in space science help the environment	67.1%	71.4%	+4.3%
Discoveries in space science make our lives easier	49.7%	63.3%	+13.6%

In focus group discussions, students gave some indication to why their perceptions around the importance of space science had shifted. Students often reflected on how they had learnt about how science can help us to study the planet and civilisation:

We can use science to explore the planet (Male Student, Wales)

[We learnt] about how science can actually help us discover new parts of the world and how weather can affect different parts of the country and the world (Female Student, Wales)

I also think that after many billions of years, it would be easier to move from one planet to another, to make more discoveries, and in this way our society could evolve (Male Student, Portugal)

At face value, topics of space can often appear to be of low relevance to individuals' day-to-day lives, particularly when space is not something people encounter on a daily basis or can see and touch. It was therefore positive to see that Our Space Our Future was able to promote the connections of space to the environment. The increase in positive responses to the survey statements and students' reflections of their learning gains are indicative that the two GLOs were achieved:

- S7: Students understand the importance and value of space science in society
- S9: Students recognise the relevance of space science to environment issues

Accessibility

The accessibility construct was designed to explore students' perceptions of the types of people who work within the space industry. A key aim of the Our Space Our Future project was to promote the multiplicity and diversity of the space industry in terms of the jobs available and the people who work within it. 'Space' was promoted to students as not only involving space exploration and astronomy, but also includes Earth observation, remote sensing, geospatial mapping, and many more. This construct relates to the following GLO:

- S8: Students recognise the diversity of people who work in the space industry

The statements relating to the accessibility of the space industry was an area where large increases were seen following the Our Space Our Future interventions. As highlighted in Table 9, the proportion of students who agreed that 'all kinds of people work in the space science industry'; rose by 10.2% following the interventions, and 'people from different countries work in space science' rose by 7.4%.

Table 9 – Students' agreement with 'Accessibility' statements, pre- and post-interventions

Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change

All kinds of different people work in the space science industry	59.1%	69.3%	+10.2%
People from different countries work in space science	77.9%	85.3%	+7.4%

This increase appeared to be a result of the Our Space Our Future project discussing the atypical, often abstract roles in the space industry that were less familiar to students. Students were even able to speak and ask questions to individuals working in these roles during the Our Space Our Future interventions.

Following the interventions, one teacher in England reflected on how his students' perceptions had shifted and that Our Space Our Future had enabled them to make connections between common vocations and the space industry:

> *I think the way that the ambition of working within the space sector did open up to them, I don't think they realised that actually, if you're going to be a cleaner, you can also clean in the space sector, or if you're an accountant, they need an accountant... they need doctors, they need nurses. So, I think it broke down the misconception that somehow it would be accessible like that, because there's a range of different work you can do, other than being an astronaut.*
> (Secondary School Science Teacher, Male, England).

Students themselves reflected on how the Our Space Our Future project had shown them careers that they had not known to exist. Evidence of this new learning and understanding gained by students is detailed in Point of Impact #2.

POINT OF IMPACT #2

Student Recognition of the Diversity of Space

Our Space Our Future set out to focus on careers within the space industry beyond those of an astronaut or research scientist. One of our key objectives was to draw students' attention to the more unexpected career opportunities within the industry. Feedback from both students and teachers highlighted that we had been successful in challenging students' preconceptions and had successfully demonstrated the variety of careers available in the space industry.

During focus group discussions, students were asked about what job roles were needed in the space industry and if they could provide any examples. Students listed a variety of jobs and also mentioned the "*different sections*" of the space industry:

Doctors, engineers, chefs, technicians, trainers and astronauts, someone who can take care of plants (Multiple Students, Denmark)

We also learned that there are different sections, like design, like biology and like the more research side of it (Male Student, England)

Although these examples are common, well known careers, some students reflected on how they had learnt about career opportunities they had not heard of before Our Space Our Future:

Without this project, I would never know that there are so many professions related with space exploration (Male Student, Portugal)

There are many space professions that no one had any idea they existed (Male Student, Portugal)

I didn't know that scientists... there were so many different things you can study. I learnt there were so many different subcategories (Female Student, England)

Despite the quotes reported in Point of Impact #2, one student in Portugal rightly pointed out that space does not have an equivalent for all professions:

There are many professions on Earth that don't go so well with space… being a soldier, a footballer, a firefighter… I don't think you can put out a fire in space (Male Student, Portugal)

However, a teacher also commented on how Our Space Our Future highlighted important connections between space and other topics and subjects that helped them as teachers to demonstrate the purpose of the school curriculum and why it is important to study particular concepts and subject matter:

Sometimes we get that question 'what's the point? What's the point in doing science? I'm never going to use it' so it's an aid to that, where you can say, well there's all these different careers that you may need science for. And they talked as well about the technology and the space programme and that sort of thing. So again, it's a complement to help us answer those 'what's the point?' questions. (Secondary School Science Teacher, Male, England)

In post-intervention focus group discussions, one area of exploration was around how students describe the people who work in the space industry and what skills they think they would have. Students often mentioned the need for high levels of knowledge in terms of science, coding, finances and problem-solving. They also described space industry professionals as being brave and curious in the context that they had to face the unknown, face dangers and be away from family. Some also mentioned a psychological element and a need to train your mind. A 'space industry professional' profile was created based on these descriptions the students provided and is summarised in Figure 2.

*People working in space are **curious**. Until some years ago we didn't know much about space so they had to **face new things*** – Male Student, Italy

*One of the important roles is the **management of finances** to support the space project. There are decisions that involve billions of dollars and the **pressure must be very high*** - Male Student, Italy

*They must have **a lot of knowledge*** - Male Student, Portugal

*They face the **unknown*** – Female Student, Italy

Figure 2 – Profile of a Space Industry Professional

Bravery**... **confident - Male Student, England
You have to be **away from your family** – Female Student, Denmark

*They need **science*** – Female Student, Wales

*They'd definitely need to study a **lot of science*** – Male Student, England

*It's not like a normal job here on Earth because they are in space, it's much more **dangerous** for them* - Male Student, Portugal

Problem solving – Male Student, Wales

*Psychologists have to do with space [...] you must **train your mind*** – Female Student, Italy

*I think those experts who are dealing with **coding** are so **crucial**. I took part in another project, and I realised that if you make the wrong decision while coding you can **jeopardise the space mission*** - Male Student, Italy

It was apparent from the evidence discussed that increasing students' perceptions of the accessibility and diversity of the space industry was an area of high impact for Our Space Our Future, and thus the GLO S8: students recognise the diversity of people who work in the space industry was achieved.

Possible Selves

Given the substantial research that has demonstrated how many young people hold a perception that science 'is not for me' (Archer et al., 2013), a key objective of the Our Space Our Future project was to promote a perception among the student audience that space is an accessible industry and a possible career option for their future. We therefore sought to measure students' perceptions of their "possible selves" (Markus and Nurius, 1986). The possible selves construct represents an individual's perception of what they can and might become in their future.

Given the context of space, Our Space Our Future was highly conscious of the reality that an astronaut or a top research scientist can be very idealistic and competitive careers that many young people feel are beyond their reach. Our Space Our Future therefore did not set out to inspire student audiences to these careers specifically, but instead sought to demonstrate that just because they might not be an astronaut, that does not rule them out of working in the space industry and that there is a role for everyone. Thus, having demonstrated how Our Space Our Future promoted the diversity of the space sector and its accessibility, we also wanted to extend this to students' personal perceptions: helping them to find their own identity with space and feel a sense of capability and empowerment in pursuing a career in the space industry. The possible selves construct therefore applied to GLO S3: Students perceive space science to be accessible to them.

From the baseline data from students, the three statements in the survey that related to students' possible selves, did not receive particularly positive responses. As summarised in Table 9, at the baseline, less than 50% of students agreed or strongly agreed they were clever enough, could develop the skills, or could work in the space industry if they wanted to.

Unfortunately, students' perceptions following the Our Space Our Future interventions were relatively unchanged. As can be seen in Table 10, although there was a small increase in the proportion of positive responses for two of the statements, for one statement, there was a small decrease.

Table 10 – Students' agreement with 'Possible Selves' statements, pre- and post-interventions

Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change
I am clever enough to work in the space science industry	27.1%	31.2%	+4.1%
I could develop the skills needed to work in the space science industry	49.3%	50.9%	+1.6%
I could work in the space science industry when I grow up if I wanted to*	37.8%	36.2%	-1.6%

The distribution of students' responses to these statements even on the post-intervention survey was indicative of the mixed views held by students. These mixed perceptions were also evident from focus group discussions with students.

It was promising to see that some students reflected on how the Our Space Our Future project had broken down the stereotypes of who works in the space industry and highlighted the different areas of the school curriculum that apply to space. In some instances, this led students to perceive the space sector as a "*more realistic*" career opportunity for them and offered much broader opportunities than they had initially thought:

I always thought of being an astronaut or scientist as a really out-there job, obviously only a very select couple of people got to do… but seeing that there's so many different scientists around the world and there's different things… I guess it made it a little more realistic as a job to have (Female Student, England).

There's so much you can do. It's not just about being an astronaut, you can do so much. (Male Student, England)

From the meeting with the experts in astrophysics during the first intervention I learnt that the curriculum could be more accessible than I expected […] I learnt about new specialisations connected with space (Female Student, Italy)

These reflections indicate that Our Space Our Future was successful in promoting careers in the space industry beyond those of astronauts and students were able to consider other opportunities available to them. However, there still remained a perception among students that even these other career opportunities were overwhelming and they did not perceive the space industry to be a realistic career pathway for them:

It'd be alright, but it takes quite a lot of skill to do it sometimes and I don't have a lot of skills (Male Student, England)

I don't know If I could succeed because there are many unknown things [about space] (Female Student, Italy)

Given the apparent success in promoting the diversity of the space industry, but the remaining perception among some students that such a career is not suited to them, we attempted to explore the reasons for this disconnect. Where students were asked about what they perceived to be key traits and skillset of individuals working in the space industry (see Figure 2), we wanted to explore how these descriptors compared to how they would describe themselves and their own characteristics.

Where students' perceptions of the characteristics of someone working in the space industry included bravery, confidence and ability to work in dangerous scenarios, many felt that they themselves did not hold these characteristics and perceived a career in the space industry as somewhat daunting. This is evidence to suggest that GLO S3: students perceive space science to be accessible to them, was not entirely achieved and that more work is required in this area. This was an important finding from the project and is summarised in Remaining Challenges #1.

REMAINING CHALLENGES #1

The Space Industry is a Daunting Career Path

*I don't think I want to have any profession related to space because I think it will be **life changing**, and I think it will be **difficult***

Male Student, Portugal

*I don't know if I have the **bravery** for it and the **courage** for it.*

Male Student, England

*I don't know If I could succeed because there are many unknown things, I **admire them** because they **face the unknown***

Female Student, Italy

*I don't like the thought of travelling to space [...] and **maybe you won't come back**, and you have to be **away from your family***

Female Student, Denmark

One important finding from focus group discussions was students' expressive descriptions of their perception of space as a daunting, dangerous career path that requires "*courage*" and "*bravery*".

Many reflected on the challenges and "*dangers*" of travelling to space, however others also maintained even with other space industry careers, those involving "*not just being an astronaut*" were also difficult, hard work, and required you to be away from your family.

This is an important finding when aiming to promote such careers to young people and considering what values these young people hold when making decisions about their future.

*I think one of the important roles is about management of finances to support the space project. There are decisions that involve billions of dollars and the **pressure must be very high***

Male Student, Italy

*If I was going to space, I can't even fit in that little room [space capsule], I feel like I'm getting **stressed**.*

Male Student, Denmark

*But you definitely have to be **away from your family a lot**. Like, the whole time because you'd have to be **doing a lot of work***

Male Student, Denmark

Future Aspirations

Having explored students' interest in space science and whether they feel empowered to pursue such a career, we also explored students' desire to pursue such a career. This was captured by the future aspirations attitudinal construct and ties with two GLOs:

- S5: students want to learn more about careers in space science
- S6: students consider pursuing a career in space science

There were pockets of evidence to indicate some students would consider such a career. However, it was not always clear whether this was a result of the Our Space Our Future interventions, and in some cases, it was apparent that these aspirations were pre-existing:

I remember the first meeting with astrophysicists that helped me to develop ideas about my future… During this meeting I would have liked more time to receive suggestions from them about future choices (Female Student, Italy)

I would be interested in becoming a Space engineer (Male Student, Italy)

I've always wanted to become an astrophysicist (Male Student, Denmark)

I would consider becoming an astronaut… I would like to (Male Student, Denmark)

Unfortunately, the general consensus among students appeared to be against pursuing careers in the space industry and as such, the GLO S6: students consider pursuing a career in space science, was not achieved. As summarised in Table 11, even after the Our Space Our Future interventions, little over a quarter of students reported a desire for a job related to space science and only a fifth reported that they would like to work in the space science industry.

Table 11 – Students' agreement with 'Future Aspirations' statements, pre- and post-interventions

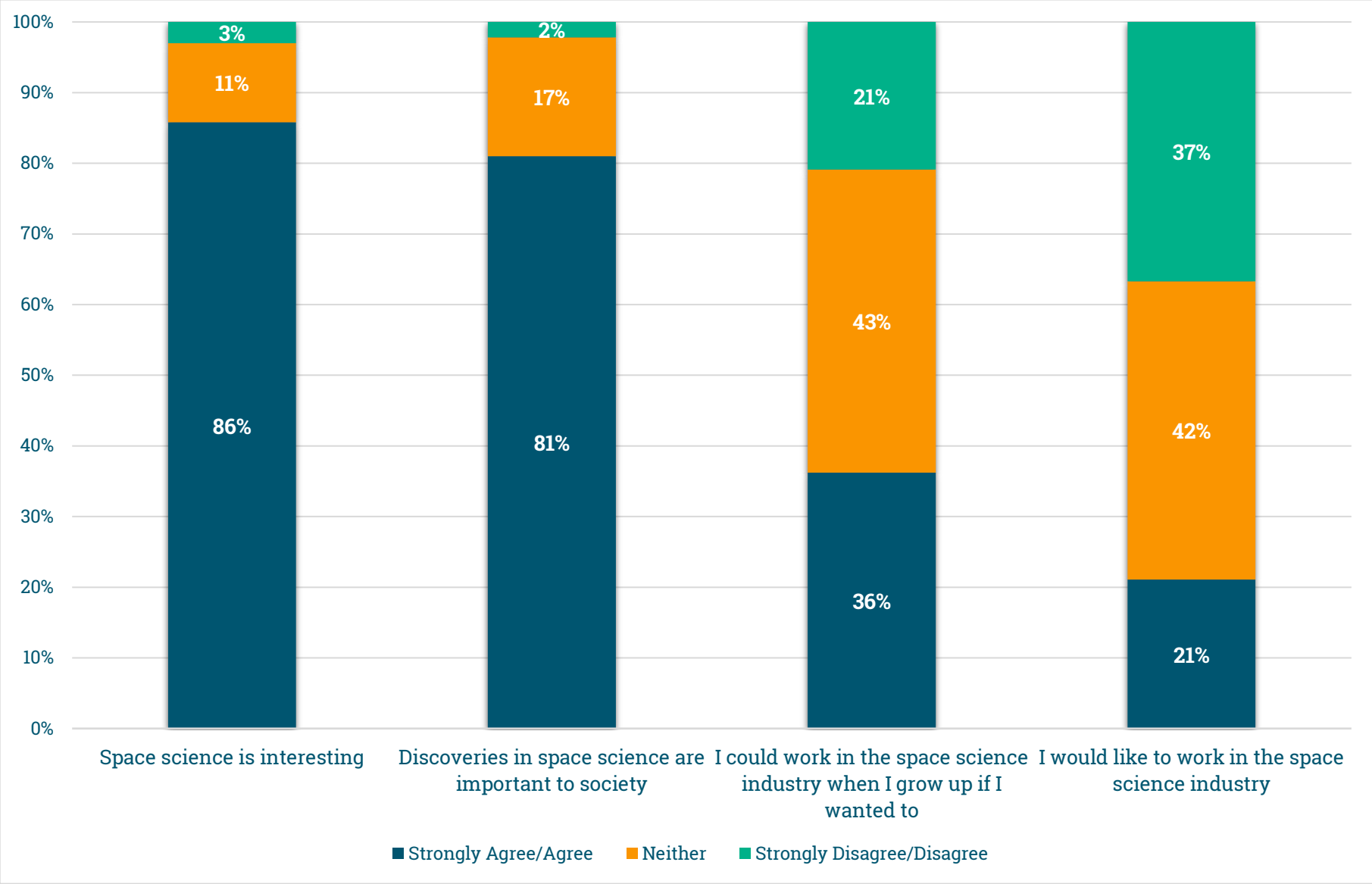
Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change
I would like to find out more about jobs in the space science industry	56.7%	58.6%	+1.9%
I would like to have a job related to space science	25.3%	27.1%	+1.8%
I would like to work in the space science industry	21.4%	21.1%	-0.3%

Slightly more positive responses were obtained in terms of students' desire to find out more about jobs in the space industry. Although only a marginal increase was recorded following the Our Space Our Future interventions (first row in Table 11), this desire was still evident in more than half of the student cohort (58.6%). This could be considered an opportunity for educators. Where Our Space Our Future had success in promoting the diversity of the space industry, and at the very least, sustained students' desire to learn more about relevant careers, if educators can continue with this approach and inform students about the variety of career opportunities available to them, perhaps eventually, the desire among students to pursue these careers will follow. With this view, GLO S5: students want to learn more about careers in space, can be considered to be partially achieved

Nonetheless, we are still faced with a student cohort whereby the majority do not have a desire to work in the space industry or work in a relevant role. Figure 3 provides a visual representation of the finding that even where interest among students is high, their aspirations remain low.

The four bars display post-intervention data from students. On the far left, it is evident that over 80% of students agreed that space science is interesting. A similar result was seen in terms of the importance of space science to society (inner left). However, as the statements become more personal; probing students' confidence and sense of their possible selves (inner right), suddenly we see a greater proportion of disagreement and indifference (neither agree nor disagree). The blue area of the bar, representing the proportion of agreement with the statements has shrunk and the green area, representing disagreement has expanded. Agreement and positive perceptions decrease again when we look at students' actual aspirations (far right), where the blue agreement section now consumes the smallest area of the chart. This data echoes the wider narrative within existing literature whereby general interest in an area is not sufficient to translate into aspirations to relevant careers (Archer et al. 2020; DeWitt and Bultitude, 2018). This narrative is described in Remaining Challenges #2.

Figure 3 - Visual Representation of Differences between Students' Interest, Perceived Relevance, Possible Selves and Future Aspirations



REMAINING CHALLENGES #2

Interest is Not Enough

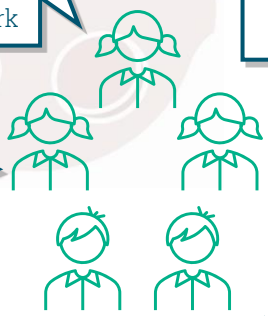
Students' desire to learn more about career opportunities in the space science industry were largely unchanged after the Our Space Our Future interventions. Focus groups discussions enabled us to delve into why the project had been unsuccessful in shifting this perception among the majority of students. When talking about careers in the space industry, students were forthcoming in expressing their interest in space, but not perceiving it as a career 'for them'. This echoes the findings from the ASPIRES project where triggering interest in students' is not sufficient in inspiring pursuit of a relevant career pathway.

It would be interesting to travel up there [to space], but I just don't feel like doing it myself.

Female Student
Denmark

It's still not really what I want to do. I want to do something more medical with life sciences

Female Student
England



It's interesting, but it's not really for me

Female Student
England

Although I think space is important, I don't think it is something concrete for me. I do prefer biology but not related to space.

Male Student
Italy

It's quite cool, but I don't think I would do it

Male Student
England

Results by Gender

Having discussed the overall results in terms of the five key attitudinal areas across the entire student cohort, we then explored whether there were any differences in outcomes according to student groups, namely, gender and country. When comparisons were performed within gender, it was evident that the difference between attitudes pre- and post-intervention was greater for female students compared to male students for 12 out of the 14 survey items. That is, for 12 of the survey statements, **there was a greater increase in the proportion of positive responses for female students than for male students.**

The differences in the proportion of male and female students that agreed or strongly agreed with each statement between pre- and post-intervention is summarised in Table 12.

Table 12 – Attitude Change of Students Pre- and Post-Interventions by Gender

Statement	Change in Proportion of Agreement with Statements between Pre- and Post-Intervention	
	Male	Female
Space science is interesting	6.7%	**10.7%**
Discoveries in space science are important to society	2.4%	**4.5%**
People from different countries work in space science	5.1%	**10.0%**
I could work in the space science industry when I grow up if I wanted to	**-1.9%**	-2.1%
All kinds of different people work in the space science industry	9.5%	**11.2%**
I enjoy learning about space science	5.6%	**11.2%**
I would like to find out more about jobs in the space science industry	1.5%	**3.0%**
I would like to work in the space science industry	**0.7%**	-1.9%
I am clever enough to work in the space science industry	2.7%	**4.9%**
Discoveries in the space science help the environment	3.9%	**4.4%**
I would like to have a job related to space science	1.0%	**2.3%**
Discoveries in space science make our lives easier	10.8%	**16.6%**
I could develop the skills needed to work in the space science industry	-0.3%	**3.9%**
I would like to learn more about space science	0.2%	**0.8%**

The two exceptions were the statements 'I could work in the space industry when I grow up if I wanted to' where a smaller proportion of both male and female students agreed with this statement after the interventions, but a greater reduction was evident for females, and for 'I would like to work in the space industry', where male students showed a slight increase in agreement following the interventions (+0.7%) and female students showed less agreement (-1.9%).

In the baseline results, chi-square cross-tabulations demonstrated significant differences between the attitudes of male and female students for 12 out of 14 items. When looking at post-intervention data, **significant differences between these genders were only evident for three of the 14 items**. These three items included 'all kinds of different people work in the space science industry', 'I would like to work in the space science industry', and 'I would like to have a job related to space science'. Female students gave more positive responses to the first statement and male students gave more positive responses to the latter two.

These results are suggestive that the Our Space Our Future interventions had a more positive influence on students who identified as female, than those who identified as male. Although we cannot ignore that in the post-intervention data, male students remained significantly more positive than female students in their career aspirations in the space industry, the increase in the proportion of students who agreed with this statement following interventions was greater for female students (increase of 2.3%) than for male students (increase of 1.0%). In accounting for these results, we can consider that the attitudes among students are moving in the right direction and that **Our Space Our Future was successful in narrowing the gap between these genders**.

Results by Country / Delivery Partner

Before exploring the evaluation data according to country (delivery partner), it is important to highlight that each of the delivery partners within Our Space Our Future are unique, established science educators and communicators with a wealth of experience that extends beyond this project. Each of the countries involved in Our Space Our Future: Denmark, England, Italy, Portugal and Wales also present their own needs and challenges in terms of STEM education.

The needs of audience groups also changed dramatically with the onset of the Covid-19 global pandemic that saw school closures, a shift to online learning, and social distancing regulations. As a result, each delivery partner had to adapt to their own circumstances and environment and deliver the Our Space Our Future project in a feasible, safe and engaging way for their audience. As a result, different approaches were taken and new experiences of good practice was achieved.

In order to capture the activities in each country, individual case studies for each delivery partners' student interventions have been compiled to demonstrate the objectives of these interventions and the impact on their students. The following pages provide individual intervention case studies for each of the delivery partners, detailing some of the engagement activities that were implemented. Unfortunately, for Portugal, data around their interventions was not provided and so an intervention case study could not be compiled for this country.

INTERVENTION CASE STUDY #1

Planetarium - Denmark

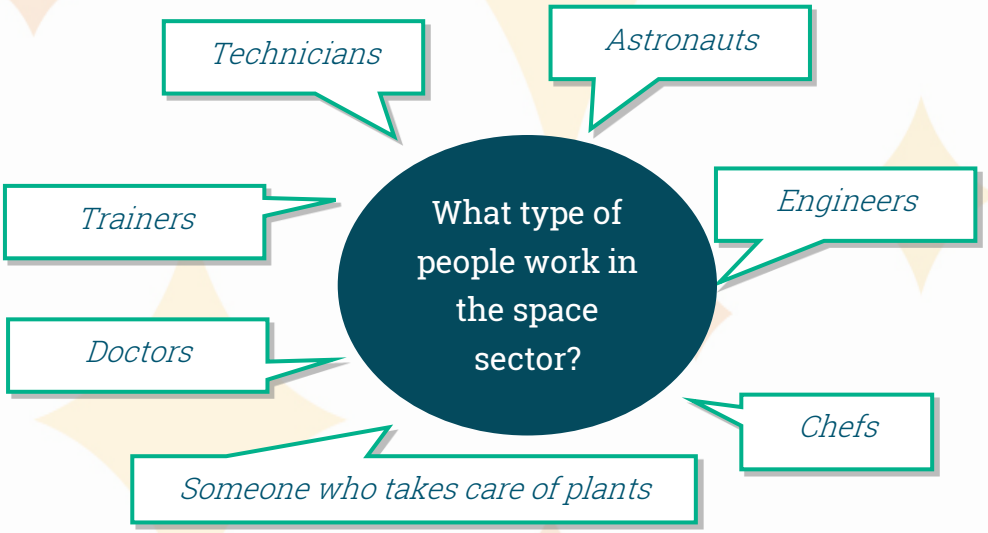
Planetarium was the delivery partner for Our Space Our Future in Denmark. Planetarium was the only partner who had a venue where audiences (typically) visited them, rather than the staff going to visit their audience, as with other delivery partners.

A key objective of Planetarium's interventions was to "***highlight to students, the many different professionals working with space***"

In focus group discussions, one student highlighted that she had learnt about the different roles that are needed for space missions:

We need to bring all kinds of different people [on space missions] …We need a doctor… and we need people who can cook …and all kinds of things… (Female Student, Denmark)

When asked to elaborate on the type of people who work in the space industry, all of the students in the focus group contributed their ideas:



These comments provide evidence towards the achievement of GLO S8: students recognise the diversity of people who work in the space industry.

INTERVENTION CASE STUDY #2

Explorer Dome - England

Explorer Dome was the Our Space Our Future delivery partner based in England. For their interventions, their objectives focused on promoting the diversity of space and STEM, and the variety of possible career pathways:

We were aiming to make space science accessible, to enable a more diverse range of students to participate in STEM activities [...] We also aimed to broaden the perception of what space science is beyond the traditional roles of astronauts and to open up the sector to those who are less confident in academic pathways and are more practically minded – promoting the diversity of space opportunities, careers and pathways into space. (Explorer Dome, England Delivery Partner)

To achieve this, one of the interventions involved meeting different space scientists. Students were able to hear from and pose questions to three space scientists: an astrobiologist, a planetary scientist studying Mars, and a climate (cryogenic) scientist. From focus group discussions, it was evident that meeting these 'real scientists' provided a realistic representation of scientists rather than typical stereotypes portrayed in film and media. Students also appreciated the opportunity to ask their own questions:

I liked it when we did the Teams call with the scientists because people talk about what it is like being a scientist and stuff but it was the first time for me, actually meeting a real scientist instead of you know, a 'Back to the Future' sort of scientist. (Female Student, England)

I liked it because we got to ask them [the scientists] questions about stuff you didn't already know so I liked that. (Male Student, England)

Some students also reflected on how the Our Space Our Future project had helped them to see the different career paths within the space industry, beyond being an astronaut:

There's so much you can do. It's not just about being an astronaut you can do so much that's involved with it. (Male Student, England)

We also learned there are different sections like design, like biology, and like more research side of it. (Male Student, England)

I didn't know that for scientists, there was so many different things you can study [...] so many different sub-categories. (Female Student, England)

INTERVENTION CASE STUDY #3

Psiquadro - Italy

Psiquadro was the Our Space Our Future delivery partner based in Italy. A key objective of their interventions was to enable students to "***enjoy the spirit of discovery through engagement formats of various kinds: play, build, solve problems, compete, and work together***".

Due to Covid-19 restrictions in Italy, Psiquadro were not always able to go into schools. However, they were still able to remotely deliver two interventions that guided students through hands-on practical activities they could do in their classroom. The students had to complete a Space Challenge that involved three key stages:

1. Design a lander that must protect fragile equipment [an egg!] inside it
2. Test the prototype and observe and comment on the physics, maths and engineering involved
3. Discuss and debate technological solutions to solve problems faced in landing missions

Psiquadro reflected on the positive implementation of the Space Challenge:

The practical activities worked very well because they succeeded to actively engage pupils. The challenge helped to present ordinary everyday objects under a new light connected with space building challenges. (Psiquadro, Italy Delivery Partner)

Students' reflections in focus groups discussions echoed how they had experienced skills such as teamwork, working together, and building things, all through the medium of space:

I learnt the spirit of teamwork to build something together thanks to the tinkering experience with Space challenges (Male Student, Italy)

I learnt how to use everyday material to build objects (Male Student, Italy)

I really like the practical workshop to protect an egg because in our schools we don't usually do workshops and I really enjoyed building a spaceship to protect an egg (Female Student, Italy)

INTERVENTION CASE STUDY #4

Science Made Simple - Wales

Science Made Simple was the Our Space Our Future delivery partner based in Wales. For their interventions, one of their objectives was to "***allow students to develop their own interest in the topics of space and STEM subjects***".

SMS reflected that this had been achieved by embedding student-led research and questioning into their interventions. One of the key highlights from interventions reported by SMS was that:

The engagement of students who often show less motivation and engagement in a traditional classroom environment (Science Made Simple, Wales Delivery Partner)

In focus group discussions, the students were asked what they liked about the Our Space Our Future activities. A common reflection was the opportunity to be actively involved in their learning, rather than being a passive observer. Students felt this experiential approach was helpful to their learning:

The reason I've enjoyed it is because it's entertaining, you get to join in in fun activities, you get to participate, and it just makes you happy. (Female Student, Wales)

Yeah it's fun! And actually being there, I like physical things, I'm more of a physical learner so I like it when I can be joined in. (Female Student, Wales)
I learn better when I actually do things [...] It's fun because we can actually do it. (Male Student, Wales)

You actually get to be somewhere that you can get involved with things. (Female Student, Wales)

On the broad, quantitative level, the pre- and post-survey data from students was compared between countries (delivery partners), as was done for gender. From baseline data, chi-square cross-tabulations demonstrated significant differences ($p \leq 0.05$) between countries for all 14 statements. For post-intervention data, significant differences were evidence for 13 statements, the one exception was 'I am clever enough to work in the space industry'. Effect sizes ranged from 0.086 (small) to 0.357 (small). The smallest effect size was obtained for the statement 'people from different countries work in space science', the proportion of students who agreed or strongly agreed with this statement ranged from 81.3% (Portugal) to 91.5% (Italy), yielding a range of 10.2%. The largest effect size was seen for the statement 'all kinds of different people work in the space industry'. Here, the proportion of students who agreed or strongly agreed ranged from 27.0% (Italy) to 90.4% (England). It is unclear why students in Italy held such low agreement with this statement, however this was also apparent at baseline data collection.

Table 13 summarises the differences in students' responses pre- and post-interventions by country. The country with the largest increase in positive responses between baseline and post-intervention is highlighted in bold text. Denmark only has results for five of the statements as all students who completed the post-intervention surveys completed the adapted, special educational needs and disability version of the survey which had reduced items. Individual tables of each country's pre- and post-intervention results are provided in Appendices 2-6.

From Table 13, it is evident that there were a variety of points of impact across the Our Space Our Future delivery partners. England were the only country to see only increases in the proportion of positive responses among students for all statements, where other countries yielded small decreases in positive responses in some areas.

For **Denmark and Portugal**, the greatest increase in positive responses from students was for the statement '**all kinds of different people work in the space science industry'**. The proportion of students who strongly agreed or agreed with this statement **increased by 11.9% in Denmark and 11.5% in Portugal**.

In **England**, the greatest increase was seen for the statement '**I enjoy learning about space science**' which **increased by 19.1%.** This was also the biggest increase that was yielded for any statement and for any country.

In **Italy**, the greatest increase was found for the statement '**discoveries in space science make our lives easier**' which **increased by 11.2%.** Also related to the relevance of space science, **Wales'** saw the greatest rise for the statement '**discoveries in space science help the environment'** which **increased by 15.6%.**

Table 13 – Attitude Change of Students Pre- and Post-Interventions by Country

Statement	Change in Proportion of Agreement with Statements between Pre- and Post-Intervention				
	Denmark (PDK)	England (ED)	Italy (PSC)	Portugal (NUC)	Wales (SMS)
Space science is interesting	-	**+18.7%**	+2.8%	+2.4%	+10.2%
Discoveries in space science are important to society*	+1.6%	**+8.2%**	+4.1%	-0.3%	0.0%
People from different countries work in space science	-	**+11.7%**	+5.3%	+8.3%	+8.7%
I could work in the space science industry when I grow up if I wanted to*	+0.3%	**+5.5%**	-3.0%	-2.5%	-0.2%
All kinds of different people work in the space science industry*	**+11.9%**	+10.3%	+5.5%	+11.5%	+3.2%
I enjoy learning about space science*	+8.0%	**+19.1%**	+3.3%	+1.2%	+0.8%
I would like to find out more about jobs in the space science industry	-	**+5.6%**	+2.4%	-3.7%	-0.4%
I would like to work in the space science industry*	-3.9%	**+10.3%**	-4.7%	-1.8%	-0.1%
I am clever enough to work in the space science industry	-	+5.3%	**+8.5%**	+1.3%	+3.2%
Discoveries in the space science help the environment	-	+3.3%	+9.9%	-5.5%	**+15.6%**
I would like to have a job related to space science	-	**+10.9%**	-0.2%	-4.1%	+1.8%
Discoveries in space science make our lives easier	-	+7.2%	**+11.2%**	+8.8%	+13.7%
I could develop the skills needed to work in the space science industry	-	+1.2%	**+6.2%**	+1.5%	-2.8%
I would like to learn more about space science	-	**+8.9%**	+2.0%	-2.8%	-4.2%

*Statements that were included in the SEND version of the student survey

Alternatively, the more problematic areas for the five countries, and those statements that saw the least improvement, or even reduction, in positive perceptions, were more closely related. These statements typically concerned students' future involvement in space science.

For Denmark and Italy, there was a decrease in the proportion of positive responses to the statement 'I would like to work in the space science industry'. The proportion

of students who agreed with this statement decreased by 3.9% in Denmark and 4.7% in Italy. In Wales, a smaller proportion of students indicated after the interventions that they would like to learn more about space science (-4.2%).

Although Portugal did see reductions in the statements relating to careers in space, the greatest reduction was seen for the statement 'discoveries in the space science help the environment' where the proportion of students who agreed with the statement decreased by 5.5%.

In England, it was apparent that student agreement did not decrease for any of the survey statements following the Our Space Our Future interventions. For all statements, the proportion of students who indicated agreement, increased following their interventions. The statement that yielded the smallest increase of 1.2% was 'I could develop the skills needed to work in the space science industry'.

However, an important finding is that England saw substantial increases for the statements 'I would like to work in the space science industry' (+10.3%) and 'I would like to have a job related to space science' (+10.9%). This is in contrast to other countries who yielded a decrease in agreement with these statements, or only a marginal increase. These results are indicative that England had some success in improving students aspirations in space science. Such a finding is of great importance, particulary when the general pattern across the entire Our Space Our Future student cohort (across all countries), was that students' interest was high but their aspirations were low.

In order to understand how such a change was induced and what engagements led to these increased aspirations, a presenter from Explorer Dome was asked to reflect on their approach and how they promoted careers in space to their student audience. A summary of their reflections is provided in Point of Impact #3 and provides valuable examples of good practice that can be adopted by other partners and similar education projects to increase students' aspirations further afield.

POINT OF IMPACT #3

Shifting from Interest to Aspiration

When asked about their approach to promoting careers in the space industry and conveying this to student audiences, Explorer Dome reflected on their discussions with students' teachers in the very early stages of the project understand what the students were interested in. This provided Explorer Dome with a lens to frame their approach and tailor their interventions to align with students' interests:

We had three meetings with the teachers before [interventions] focusing on what we were trying to do in terms of diversity of space careers and how we could play that. […] so, they were like 'ohh, it would be really good if we could have someone like this, 'cause that's quite useful for what we've been talking about in school' or, 'there's a couple of kids who are really into this', and 'do you have anyone who actually does space engineering?' that sort of stuff.

Interventions were flexible and the Explorer Dome presenters responded to students' comments and interests by highlighting their connections with space, no matter how extravagant they seemed. This helped students to realise their potential niche in the space industry:

There was a kid who was just like, 'no, I'm not into space or science, I'm going to be a hedge trimmer', and his dad's into topiary or a gardener. And then there was a hilarious offshoot conversation which got everyone laughing. The presenters ended up talking about the possibility of growing and farming on Mars in the future, and the fact that we are going to need Mars hedge trimmers! So, he [the student] got so into the idea of horticulture and how plants would grow on a different planet.

Learning about students' interests also helped Explorer Dome to identify appropriate role models who students could identify with and recognise similarities to their own character:

We had the space industry experts coming in and then the astrobiologist was like I was rubbish at school, I hated science, I was really bad, and then I ended up working at NASA. So, there's other ways in.

Explorer Dome also paid close attention to how they framed science, emphasising that "***it's nothing about learning facts and having the answers to these questions, it's about having a question of your own and being a problem solver***". They also promoted the value in experiencing failure. A trainee astronaut spoke to the students and explained that "***there's no one who's got anywhere who hasn't failed***". Explorer Dome felt this message of resilience was important for anyone wanting to pursue science in the future:

It builds that ability to fail, and you only learn from failure. I think it's a good life skill if you're into science, it gives you permission to fail and try again.

However, the schools who engaged in Our Space Our Future in England were largely lunderserved groups. **Of the seven schools that Explorer Dome engaged with, six were of low socio-economic background, five had lower than national average attainment, and five had high proportions of SEND students** (three schools were SEND schools). One teacher explained how given the make-up of these schools and the background and experiences of the students, aspirations are incredibly low. **Many students do not aspire to any career at all.** This is in contrast to some of the schools with higher privileges, where many students reflected on their career aspirations:

I already know what job I want, I want to join the army. (Male Student, Wales)

One of those people who analyse crime scenes and look for fingerprints, criminal investigation (Male Student, Portugal)

A nursery teacher because I like helping with little ones… to help them gain confidence, help them start writing, start doing all their things (Female Student, Wales)

[I want to be] a doctor or judge (Female Student, Denmark)

I want to illustrate children's books (Female Student, England)

It could be considered that it is easier to encourage students to aspire to something, as with the schools in England, than it is to change students' existing aspirations, as with many students in other schools who had considered their career pathways:

I think the type of students that we've got, come from second or third generation of unemployed, so the age old question is about motivation and self-esteem about whether or not they could even get a job. A lot of the kids, weirdly aspire to sign-on [financial support from UK government], so we've got a bit of a leap from having an ambition to sign on and not work, to step towards employability and then a leap into employment. (Secondary School Science Teacher, Male, England)

Reflections on Student Interventions

In order to provide a legacy for the Our Space Our Future project, it was important to identify areas of good practice. This would benefit not only the individual delivery partners for their future projects, but wider STEM educators and communicators and large-scale projects.

The quantitative and qualitative feedback from students and teachers was crucial in understanding the experiences of the audience. However, also important was the feedback and experiences of the delivery partners, including what they learnt from the process, areas of good practice they identified, key challenges they faced and how they would do things in the future.

The following subsections therefore discuss three key learning points from partners' feedback around student interventions.

What Worked Well?

The question asked to delivery partners: **What do you think worked particularly well in your interventions? Why?**

- Inspired by the Thinking Doing Talking Science approach, the shift from a focus on correct answers and facts, towards all answers being valid and the importance of problem solving and creativity worked well with students. The use of various activities (such as planetarium shows, presenter-led shows, interactive workshops, interviews with scientists, hands-on activities and experiments, space bingo) that utilised different senses, created an environment appropriate for all learners of all abilities and for those students with special educational needs or disabilities.

- The Our Space Our Future interventions were typically student-centred. This provided the students with a sense of ownership and autonomy over their learning. For example, hands-on activities, running their own research projects, designing their own space missions, choosing topics to explore, and coming up with questions to ask scientists:

> *At one of our schools, there was one student in particular who kept asking questions during the science show. During a break, the teacher explained that this student had not been interested in space or science at all, but after the first intervention, the student had been completed hooked and had started exploring things around space himself.* (Planetarium, Denmark Delivery Partner)

- Many of the Our Space Our Future activities had a 'wow factor' that were effective in triggering interest and curiosity, even among the most disengaged students. Examples include planetary domes/planetarium, explosive/colourful demonstrations, and science experiments.

- Multiple interventions with the same class or group meant that delivery partners could build relationships with the students and students became more

comfortable over time. The students' confidence to engage in activities increased and their anxiety reduced:

> *Multiple engagements became more and more personal, (this) meant that we really felt like we got to know the individuals within the group by the end. We knew many students by name and by the end we had the opportunity to talk to them individually.* (Explorer Dome, England Delivery Partner)

- Prolonged engagement with schools also meant that delivery partners were able to build lasting relationships with teachers. Many have enquired about or are already involved in future projects with delivery partners.

- Meeting a number of different scientists with various roles in the space sector opened students' eyes to the diversity of the sector and how there could be a role for them. Students were able to ask the scientists their own questions rather than just having the scientists talk at them. This helped students to realise that scientists are "*very 'normal' people – people with families, people who lived nearby, people who had struggled academically at school, people like them*" (Explorer Dome, England Delivery Partner).

Challenges Faced and Overcoming Them

The question asked to delivery partners: What was the biggest challenge during your interventions? How did you overcome this?

- Unsurprisingly, one of the biggest challenges faced in delivering student interventions was the Covid-19 pandemic. This created a continuously changing landscape, and a great deal of uncertainty around what was possible and what regulations would change in a matter of days. This meant that it was incredibly difficult for delivery partners to manage timescales and to plan in advance.

- Relationship building with teachers and school staff was often hindered as a result of the pandemic (though see point in 'looking to the future'). School staff were very overwhelmed with the impact of school closures and restricted classroom sizes. They also faced the challenge of catching up on missed teaching time and so were extremely pushed for time and capacity to engage with external projects such as Our Space Our Future:

> *Teachers' and students' time was limited by the pressures of catching up on missed teaching time due to Covid. Getting a closer involvement with more*

teachers from the start of the project would have created more opportunities to shape all aspects of the project (Science Made Simple, Wales Delivery Partner).

- The pandemic hit after some partners had begun interventions. This along with multiple lockdowns meant that there were often prolonged periods of time between the multiple interventions with students. This made it hard to keep the momentum and flow of activities going, so often delivery partners had to 're-engage' students. The spread of interventions over multiple terms and school years also meant there were occasions where students had different teachers which created a challenge with communication:

Due to Covid, students experienced longer time between the interventions than anticipated. Generally, it was harder to maintain some of the schools in the project as some momentum was lost. We dealt with this by continuously updating teachers to keep them 'in the loop' (Planetarium, Denmark Delivery Partner).

- In many instances, delivery partners were forced to move to online delivery. Delivering content online that was initially designed for in-person delivery was a substantial challenge and required additional planning and sometimes, additional training.

Looking to the Future

The question asked to delivery partners: **If you were to run these interventions again, what would you add, remove or do differently? Do you have any advice or recommendations you would give to an organisation looking to run similar interventions?**

- Had the pandemic and social distancing restrictions not prohibited initial plans from going ahead, delivery partners would have liked to make the community events align more closely with the four student interventions. The events would have been used as a platform for students to showcase their work to their families and local community. Although, this was still achieved to some extent, had there been opportunity for in-person community events with no restrictions, the events could have been delivered on a more personal, meaningful scale than what was achieved online and asynchronously.

- The pandemic did provide some positive outcomes. Although noting the challenges of teachers' time and capacity, teachers did in some ways become more accessible for meetings as they could be done remotely, rather than needing to arrange school visits. In future, this remote communication could be used to build relationships with teachers earlier on in projects and would permit more frequent interaction:

Now that the culture, skills and facilities have changed around use of online communication methods with schools, we would use this to build relationships with teachers at the start of the project. (Science Made Simple, Wales Delivery Partner).

- For future projects, delivery partners recommend and plan to ensure content of shows and films, such as those displayed in planetarium domes, are tailored to the needs of students in terms of language, education level and content:

That film we saw was only in English, it wasn't in Danish, so we were trying to understand it but there were many difficult words (Male Student, Denmark).

Summary of Student Results

- We saw a **positive change in students' attitudes** following the Our Space Our Future interventions for **12 out of the 14 survey statements around interest, relevance, accessibility, possible selves and future aspirations.**
- The time period of more than a year between pre-and post-data gives greater merit that these results indicate **actual attitude change, rather than short-term enthusiasm**
- Students valued the opportunity to be **actively involved in their learning** and having the **autonomy** to do their own experiments, projects and presentations.
- Students gained **increased understanding of the applicability of space science** and its importance to the planet and to society.
- A large area of impact for the student cohort was in the **diversity of the space industry** and the variety of career pathways it can offer.
- Students provided **mixed reflections** around their sense of **empowerment** and **capability** to pursue a career in the space industry.
- Many students perceive the space industry to be a **daunting career path** that is dangerous, high pressured and requires you to be away from your family.
- The general consensus among students was that a **career in the space industry was not a desirable pathway** and an interest in space science is not enough to translate into an aspiration.
- However, feedback from Explorer Dome provided in the context of their positive results provided **valuable insight into how we can promote students' aspirations.**
- Interventions appear to have **narrowed the gap** in differences in attitudes among **male and female students**.
- Generic Learning Outcomes achieved:

    - S1: Students feel greater enjoyment when doing science
    - S2: Students enjoy learning about space science
    - S4: Students want to learn more about space science
    - S7: Students understand the importance and value of space science in society
    - S8: Students recognise the diversity of people who work in the space industry
    - S9: Students recognise the relevance of space science to environment issues
- Generic Learning Outcomes partially achieved:
    - S3: Students perceive space science to be accessible to them
    - S5: Students want to learn more about careers in space science
- Generic Learning Outcomes not achieved:
    - S6: Students consider pursuing a career in space science

TEACHER RESULTS

The Our Space Our Future CPD (continued professional development) programme was informed by the Thinking Doing Talking Science approach, the science capital teaching approach, and unconscious bias. Teachers involved in the Our Space Our Future CPD events included teachers of the students receiving the interventions, as well as their teaching colleagues within the school and nearby schools in the same geographical area.

Delivery of CPD events followed two strands:

- Sessions to train and enable teachers to replicate the Our Space Our Future student interventions.
- Sessions designed to empower and upskill teachers in delivering STEM and space-related content.

There were ten GLOs for teachers' engagement in Our Space Our Future:

- T1: Teachers find the CPD inspiring
- T2: Teachers find the CPD sessions useful to their classroom practice
- T3: Teachers feel that the CPD content will engage their pupils
- T4: Teachers regard space science as applicable to all students
- T5: Teachers bring space science into their classroom
- T6: Teachers use the strategies they learnt in the CPD in their classroom
- T7: Teachers inform students of career opportunities in space science
- T8: Teachers are encouraged to promote a more student-centred classroom
- T9: Teachers know how to apply space science as a context in the science classroom
- T10: Teachers understand how space science can be applied to their classroom through real-life examples

The initial plans for capturing feedback from teachers and assessing the impact of Our Space Our Future on the teacher cohort was to implement a survey at the end of their continued professional development (CPD) event (immediate survey), and a parallel survey approximately three to six months later (follow-up survey). The immediate survey was designed to explore teachers' perceptions of the value of the Our Space Our Future CPD session, if and how it is relevant to their students and their classroom practice, and any action they plan to take as a result of their involvement.

The follow-up survey was almost identical to the immediate survey but shifted the focus from teachers' intentions to teachers' actions. For example, where the first survey asked teachers what they intend to implement in their classroom as a result

of the CPD session, the second survey asked if and what they had implemented, and their view of how this was received by their students.

Unfortunately, CPD implementation faced delays due to the Covid-19 pandemic and took place much later on in the Our Space Our Future timeline than initially forecasted. For most delivery partners, implementation of the follow-up survey three to six months later was beyond the timeline of the project. Follow-up surveys could only be captured for 13 teachers in Denmark. This meant that GLOs relating to what teachers implemented in their classroom, following the CPD (T5, T6, T7) could not be evidenced. The results detailed here therefore focus on the data captured in the immediate surveys, unless otherwise stated.

Demographics

In total, 186 teachers attended Our Space Our Future CPD events. Immediate surveys were completed by 75 of these teachers, thus equating to a response rate of approximately 41.5%.

More than half of the teachers who responded to the survey were female (58.7%) and taught STEM subjects in either middle or secondary/high school. It was also promising to learn that 50 out of these 75 teachers (66.7%) had never attended a space-related CPD event before and therefore indicate the Our Space Our Future was reaching a new audience. A summary of the demographics of these teachers is provided in Table 14.

Table 14 – Demographics of Teacher Respondents to CPD Survey

Demographic		No. Teachers
Country	Denmark	39
	England	11
	Italy	2
	Portugal	17
	Wales	6
School Level*	Primary/Elementary	12
	Middle	48
	Secondary/High	44
Subject	STEM	66
	Non-STEM	9
Gender	Male	28

	Female	44
	Not provided	3
Previously Attended Space-Related CPD	Yes	25
	No	50
Total		75

*Some teachers taught across multiple school levels

Usefulness of the CPD Session

In the immediate survey, teachers were asked to indicate their level of agreement (strongly disagree, disagree, neither, agree, strongly agree) with a series of Likert-scale statements that related to the usefulness of the CPD session (to teachers themselves and to students), and their intentions of using teaching practices after having engaged in the CPD session.

Results to the statements relating to the usefulness of the CPD session are summarised in Table 15. Here it is evident that **over 90% (typically n=67 or more) agreed or strongly agreed that the CPD content would benefit their students, was inspiring, will be useful to their teaching and in engaging their students**. No teachers disagreed that the CPD session would benefit their students or help them to engage their students in space science.

Table 15 – Usefulness of CPD to Teachers and their Students

Statement	SD/D	NE	SA/A
What I have learnt in the CPD session will benefit my students	0.0%	5.3%	94.7%
The CPD content will help me to engage my students in space science	0.0%	9.3%	90.7%
I found the CPD content inspiring	2.7%	4.0%	93.3%
I think the CPD content will be useful to my teaching	1.3%	5.3%	93.3%
The CPD content will be useful in other science topics	4.0%	32.0%	64.0%

These findings are evidence that the following GLOs were met:

- **T1: Teachers find the CPD inspiring**
- **T2: Teachers find the CPD sessions useful to their classroom practice**
- **T3: Teachers feel that the CPD content will engage their students**

Although **more than half of teachers agreed to some extent that the CPD content will be useful in other science topics**, this substantially lower proportion of agreement (64.0%) is indicative that the wider applications of space science to other topics is an area to focus on in the future.

Intentions Beyond the CPD Event

Four Likert-scale statements related to teachers' intentions following the CPD event. These statements and a summary of teachers' responses are provided in Table 16.

Table 16 – Teachers' Intentions Following the CPD Event

Statement	SD/D	NE	SA/A
I will share what I have learnt in the CPD session with my colleagues	0.0%	8.3%	91.7%
I will use the strategies I have learnt today in my classroom	6.8%	13.5%	79.7%
The CPD session has encouraged me to promote a more student-centred learning environment in my classroom	10.7%	22.7%	66.7%
The CPD session will make me more effective in teaching space science	9.3%	32.0%	58.7%

It is promising to see that **over 90% of teachers claimed they would share their learning from the CPD event with other colleagues**, and no one disagreed with this statement.

However, **greater uncertainty (neither agreement nor disagreement) was evident in terms of teachers' perceptions around whether they would use the strategies from the CPD session, whether the session had encouraged them to promote a student-centred classroom and whether the CPD session would make them more effective in teaching space science.**

Although the results for these statements were still positive (the majority of teachers agreed with these statements), these represent areas to focus on in the future. The statement 'the CPD session will make me more effective in teaching space science' is of particular concern given that the CPD sessions were intended to empower and upskill teachers in delivering space-related content. It is unclear why this statement received the lowest proportion of agreement (58.7%), however, it could be because space science is not typically a large component of science teaching. These findings also indicate that the following GLO was not achieved as successfully as others:

- T8: Teachers are encouraged to promote a more student-centred classroom

We also captured teachers' intentions by asking them to indicate how often they were implementing space-related teaching activities in their classroom, prior to attending the CPD: never, once a year, once a term or more than once a term. Then, having attended the CPD event, how often they intend to implement these activities in the future.

The median results from these questions are provided in Table 17. The median response of 'once a year' to all but one question made it apparent that prior to attending the CPD session, teachers were not regularly implementing space-related activities in their classroom. However, following the CPD events, **a substantial shift was seen and the median response for all statements** was 'once a term' (Table 17).

Table 17 – Frequency of Teachers' Use of Space-Related Classroom Activities

Before the CPD session, how often did you do the following in your lessons? / Having completed the CPD session, how often do you intend to do the following?	Median Response	
	Before CPD	After CPD
Taught space science in my lessons	Once a year	Once a term
Planned lessons relating to space science	Once a year	Once a term
Ran practical activities relating to space science	Once a year	Once a term
Used space science as a context to teach other scientific concepts	Once a term	Once a term
Told my students about career opportunities in space science	Never	Once a term
Applied real-life examples of space science in my classroom	Once a year	Once a term

Reflecting on their activities **before the CPD session, 50 out of the 75 teachers reported to have never told their students about career opportunities in space science**, yielding a median response of 'never'. However, a great result was seen in that **upon completing the CPD session, many teachers' intentions were to do this 'once a term'**. Although these results only capture teachers' intentions and not actions, this result sets a good precedent for the **GLO T7: Teachers informed students of career opportunities in space science.**

It is also promising to see that a higher number of teachers intended to apply real-life examples of space science in their classroom following the CPD event. We can assume that this intended increase is indicative that **GLO T10: teachers understand how space science can be applied to their classroom through real-life examples**, was achieved.

Unfortunately, no difference was seen in the median response from teachers around using space science as a context to teach other scientific concepts, however this is likely because before the CPD, many teachers were already doing this. Nonetheless, this result is indicative that the following GLO was not achieved as successfully:

- T9: Teachers know how to apply space science as a context in the science classroom

Although it is promising to see that teachers had good intentions for delivering space-related teaching, in order to get a better understanding of how they planned to do this, teachers were asked to 'briefly explain how you plan to use what you learnt today in your classroom?' Teachers provided a variety of responses. Some detailed their intentions to highlight the diversity of job opportunities in the space industry:

> *Provide inspiration to students about job opportunities other than those they already know* (Middle School Science Teacher, Female, Denmark).
>
> *Encouraging staff to allow for mental starter in science - the big questions/Explorify/PMI [plus, minus, interesting]. Also, the importance of retrieving scientific knowledge over time and linking ideas/concepts to real life. Misconceptions need discussion time in sessions and making time for that is important. Planning for science capital so that it's not incidental*. (Primary School Science Teacher, Female, England).

Others planned to personalise their teaching more, placing students and their interests at the core of learning and making connections with local industry:

> *Interaction more focused on students, respecting their interests, culture and knowledge. Stimulate interest in scientific culture, the space area and space science* (Middle School Chemistry & Physics Teacher, Female, Portugal).
>
> *[I will] try to link space companies and experts with Welsh heritage into lessons linked to space* (Secondary School Science Teacher, Male, Wales).

This latter quote in particular is further evidence that teachers were able to recognise real-life examples of space science that could be applied in their classroom (GLO T10).

Teachers were not only a crucial audience group of Our Space Our Future but also acted as gatekeepers to larger student cohorts, offering a vehicle of cascading the Our Space Our Future resources and methods and sustaining the legacy of Our Space Our Future. In the immediate survey, teachers were asked how many students they expected to implement the CPD content with. Unfortunately, we were unable to obtain a reliable number to this questions. Where it was hoped that teachers would respond with a specific number of students, some responded with answers such as 'all of my students', or '20% of my students". Given that we do not

know the total number of students these teachers are responsible for, we could not derive a meaningful value. Nonetheless, 64 of the 75 teachers who responded to the immediate survey gave whole numbers. In total, **teachers reported that they felt they could implement the Our Space Our Future techniques and methods with 1879 students.** This translates to approximately 30 students for every teacher who engaged in a CPD event. If we apply this to the total number of teachers who attended CPD events (n=186), this would equate to the Our Space Our Future techniques and methods being used with **approximately 5,500 students in the future.**

Actions Following the CPD Event

Although we were not able to capture the actual activities of the majority of teachers following their CPD event due to the shifted timeline, in Denmark, 13 teachers were able to complete the follow-up survey. The responses from these teachers were encouraging and indicated that the Our Space Our Future CPD sessions had been beneficial to teachers and their students. **Of the 13 teachers in Denmark, 11 reported that the CPD content had been useful to their teaching, eight had used the strategies they learnt in the CPD session and 10 felt what they learnt in the CPD session had benefited their students.**

These teachers also reported the frequency they had implemented various space-related classroom activities. **Eleven of the 13 teachers reported that since the CPD event, they had taught space science in their lessons 'more than once'. Eleven teachers reported that they had ran practical activities relating to space science 'once' and 11 teachers had told their students about career opportunities in space science 'once'. Ten teachers reported having applied real-life examples of space science in their classroom one once occasion.**

Although these responses only represent a small proportion of the Our Space Our Future teacher cohort, they are encouraging of the value and applicability of the CPD content to classroom practice. Although we cannot draw firm conclusions from just 13 teachers, they provide some evidence to indicate that the following GLOs were achieved:

- T5: Teachers bring space science into their classroom
- T6: Teachers use the strategies they learnt in the CPD in their classroom
- T7: Teachers inform students of career opportunities in space science

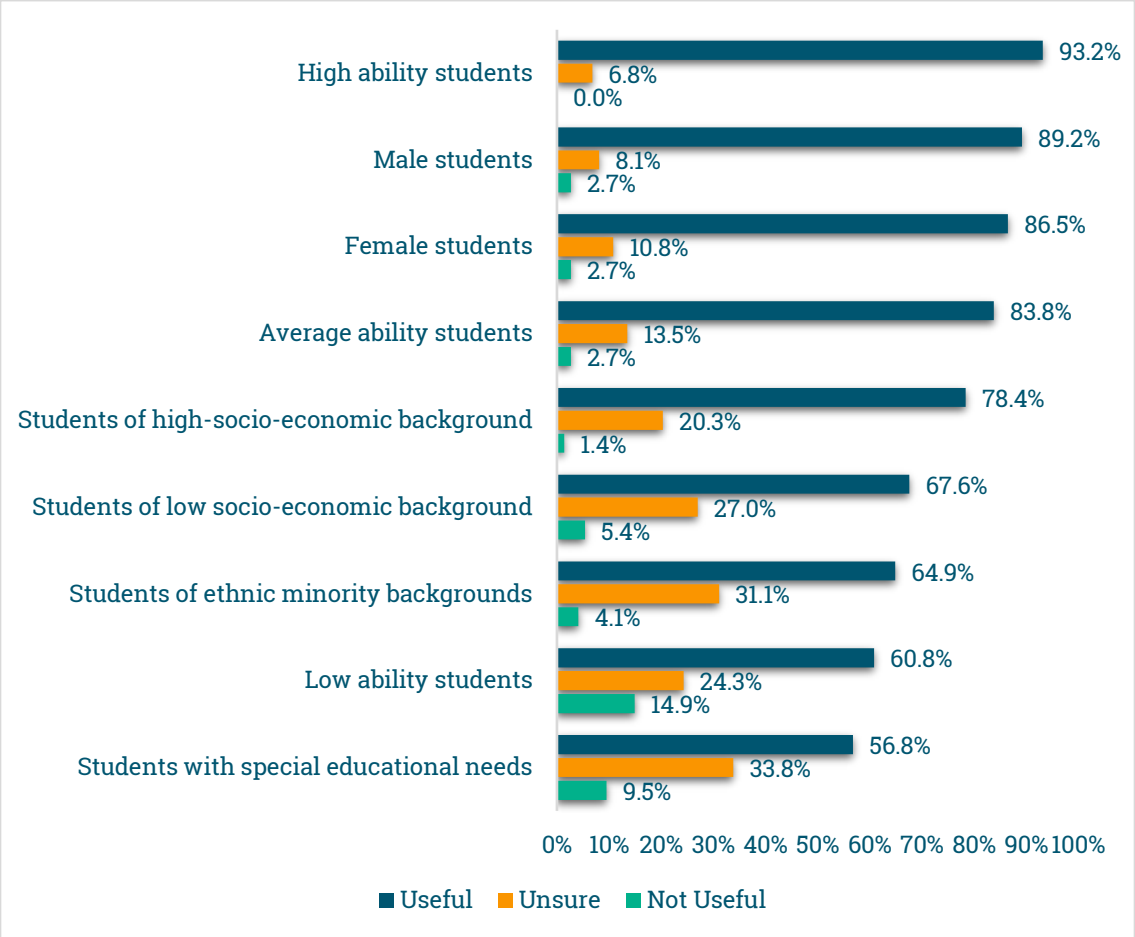
Applicability to Diverse Student Groups

In order to encourage teachers to use methods and resources from Our Space Our Future with large and diverse student groups, delivery partners strived to provide

content that teachers would deem applicable to diverse student groups, and not just high ability students.

In the immediate post-event survey, teachers were asked, 'how useful do you think the content of today's CPD will be for teaching the following student groups? Response options included 'useful', 'unsure', 'not useful'. These student groups and teachers' responses are summarised in Figure 4.

Figure 4 – Teachers' Perception of the Applicability of the CPD Session to Different Student Groups



Results are ordered in Figure 4 by student groups, starting from those for whom the highest proportion of teachers felt the CPD content would be useful. Although it is promising to see that **for all student groups, the majority of teachers felt the CPD content would be useful**, as indicated by the dominating blue line (useful) in all cases, as we begin to compare the responses across the student groups, the result is less promising.

The order of this list is arguably a reverse image of the student groups most in need and who would typically be classified as 'underserved'. Our Space Our Future set

out with an aim to target students of low socio-economic background, within ethnic minority groups, of low ability and with special educational needs.

Unfortunately, Figure 4 indicates that **more teachers perceived the CPD content to be useful for high-ability students**. In contrast, teachers were less sure on the how useful the CPD content would be for students of ethnic minority backgrounds, of low ability or with special educational needs.

Teachers were also able to provide commentary around their answers. Where teachers were concerned about the usefulness of the CPD content to particular student groups, common reflections related to the content being "*overwhelming*" or "*linguistically challenging*":

I have to admit that I struggle to think of space-related careers that our students with learning difficulties could access. However, engagement in science and enjoyment in, and understanding for the daily life is easy to achieve. (Middle School Science Teacher, Female, England)

Many students still have a lot of difficulties dealing with technologies and dealing with different platforms. (Middle School Science Teacher, Female, Portugal)

Comments from other teachers suggested that although they felt some of the CPD content was not applicable at face value, it could be adapted and differentiated appropriately:

All learning can be adapted and reapplied with other students (Secondary School Science Teacher, Male, Portugal)

I teach year 'reception' [typically ages 4-5] to year 6, and the principles and resources can be adapted to all year groups (Primary School Science Teacher, Female, England)

However, some teachers provided entirely positive reflections around the applications of the CPD content and its usability with a variety of students and learners. They commented in particular on the application of space to technology, its applicability to a variety of subjects, and its strong visual aspect that is valuable for students with additional learning needs:

The awareness of the importance of space exploration in all areas of knowledge and the application of technological advances resulting from it in the life of each and every citizen (Secondary School Science Teacher, Female, Portugal).

I think space and the ideas presented would be very engaging for ASD [autism spectrum disorder] and SLCN [speech, language and communication needs] learners (Primary and Secondary School Science Teacher, Male, England)

The contents are inspiring for the vast majority of students and free them from possible prejudices that have taken root on science and especially on space science (Middle School Science Teacher, Female, Portugal)

This is a topic that is not exhausted, nor is it restricted to this or that target audience. With the right strategies, each and every student learns and starts to reflect in their daily lives, bearing in mind the space sciences. In fact, both students and teachers, who participated in the training sessions, became much more attentive to any and all news related to the topic and recognised the importance of space exploration in their daily lives (Secondary School Science and Maths Teacher, Female, Portugal)

The mixed feedback around the applicability of the Our Space Our Future CPD content to diverse groups of students is suggestive that GLO T4: teachers regard space science as applicable to all students, was partially achieved. Although it is encouraging that for all student groups, more than 50% of teachers felt the CPD content would be useful, the uncertainty among some teachers highlights that there is more work to be done.

These results and also interesting when considering the findings in England discussed in Point of Impact #3. Where Explorer Dome (England delivery partner) were the only delivery partner to yield an increase in students' attitudes across all survey satements, they also engaged with some of the most underserved schools across the project. When interpreting these student results, it is implied that the Our Space Our Future material is in fact more suited to and has greater impact on students of lower ability and of lower socioeconomic status.

Overall, teacher feedback was indicative that the Our Space Our Future CPD events provided inspiring content that would be useful to the teachers, their colleagues, and their students. Following the CPD, teachers were intent on implementing space-related teaching in their classroom more frequently and teachers in Denmark reported having done so in their follow-up survey several months later. However, it is evident that more work is needed to promote the applicability of space to diverse student groups. This was apparent from the finding that teachers felt the CPD content was most applicable to high-ability students.

Summary of Teacher Results

- We were only able to capture teachers' immediate feedback around the CPD and their intentions for future activity for the majority of teachers, rather than any evidence of actual use
- 50 out of 75 teachers had never attended a space-related CPD event before
- Teachers found the CPD sessions to be inspiring, of benefit to their students and of use to their own and their colleagues teaching
- Teachers reported that they felt they could implement the Our Space Our Future techniques and methods with 1879 students.
- Generally, having completed the CPD session, teachers intended to include space-related classroom activities more frequently in their teaching
- Teachers typically felt that the CPD content was more applicable to high-ability students and less applicable to students of low socio-economic background, students of ethnic minority backgrounds and students with special educational needs, although views were mixed. This also contradicts the student data where impact was greater on students of lower ability and of low socioeconomic status
- Following the CPD event, teachers intended to promote the diversity of job opportunities in the space industry to their students and make connections with local industry
- Teachers in Denmark who were able to complete the follow-up survey several months after their CPD event providing encouraging evidence of the value and applicability of the CPD content to classroom practice.
- Generic Learning Outcomes achieved:
    - T1: Teachers find the CPD inspiring
    - T2: Teachers find the CPD sessions useful to their classroom practice
    - T3: Teachers feel that the CPD content will engage their pupils
    - T10: Teachers understand how space science can be applied to their classroom through real-life examples
- Generic Learning Outcomes partially achieved:
    - T4: Teachers regard space science as applicable to all students
    - T5: Teachers bring space science into their classroom
    - T6: Teachers use the strategies they learnt in the CPD in their classroom
    - T7: Teachers inform students of career opportunities in space science
    - T8: Teachers are encouraged to promote a more student-centred classroom
    - T9: Teachers know how to apply space science as a context in the science classroom

PUBLIC RESULTS

The main avenues for public engagement in Our Space Our Future was through community events and our online presence. Much detail around the Our Space Our Future online engagement is provided in Deliverable 6.3 (Report on Outreach Activity) so this is not repeated in this deliverable, however relevant feedback is described.

Two GLOs were set out for our public audience engagements:

- P1: Members of the public enjoy the community events
- P2: Members of the public engage in conversations with students and ask questions above their work

Community Event Audience Feedback

Most of the Our Space Our Future community events had to be adapted significantly from the original plans due to the Covid-19 pandemic and subsequent social distancing regulations. Adaptations varied across delivery partners but typically included events moving entirely online rather than in-person, a reduction in the size and scale of an in-person event, or simply delaying events until restrictions were eased. Naturally, such changes had an impact on both the delivery and the evaluation of these events and in the latter case, some events were delayed beyond the cut-off date for evaluation data collection. Where in-person events were not possible, this naturally impeded the extent to which we could address GLO P2 (members of the public engage in conversations with students and ask questions about their work) as audience members were not able to interact with one another as readily online as they would have been able to in-person.

Despite the challenges, some community events did proceed, and evaluation data was captured primarily through in-person graffiti walls and through the online application, Mentimeter. Delivery partners also provided detailed feedback via Partner Feedback Forms. Such feedback provided detail around the format and objectives of the individual community events that took place and thus offered valuable context to the audience feedback. These combined data permitted the construction of case studies of the Our Space Our Future community events.

Graffiti Walls and Mentimeter were used for evaluation data collected in Denmark, England, Portugal and Wales. Audience members responded to a series of statements:

- Today, I liked being able to…
- Today, I was surprised to find out that…
- Today, I was most impressed by…
- Today could have been better if…

- Following my experience today, I would like to…
- At home, my teenager told me about…
- What are the most exciting things you have experienced in the planetarium?

Audience responses across the four countries have been translated and combined to create a graffiti wall for each of these statements. These graffiti walls are presented on the following pages in Figures 5 to 10. Responses have been colour coordinated to indicate the different countries according to: Denmark, England, Portugal and Wales. No graffiti wall data was obtained in Italy.

Figure 5 – Community Event Audience Responses to 'today, I liked being able to…'

Figure 6 – Community Event Audience Responses to 'today, I was surprised to find out that…'

Figure 7 – Community Event Audience Responses to 'today, I was most impressed by…'

Figure 8 – Community Event Audience Responses to 'today could have been better if…'

Figure 8 – Community Event Audience Responses to 'following my experience today, I would like to…'

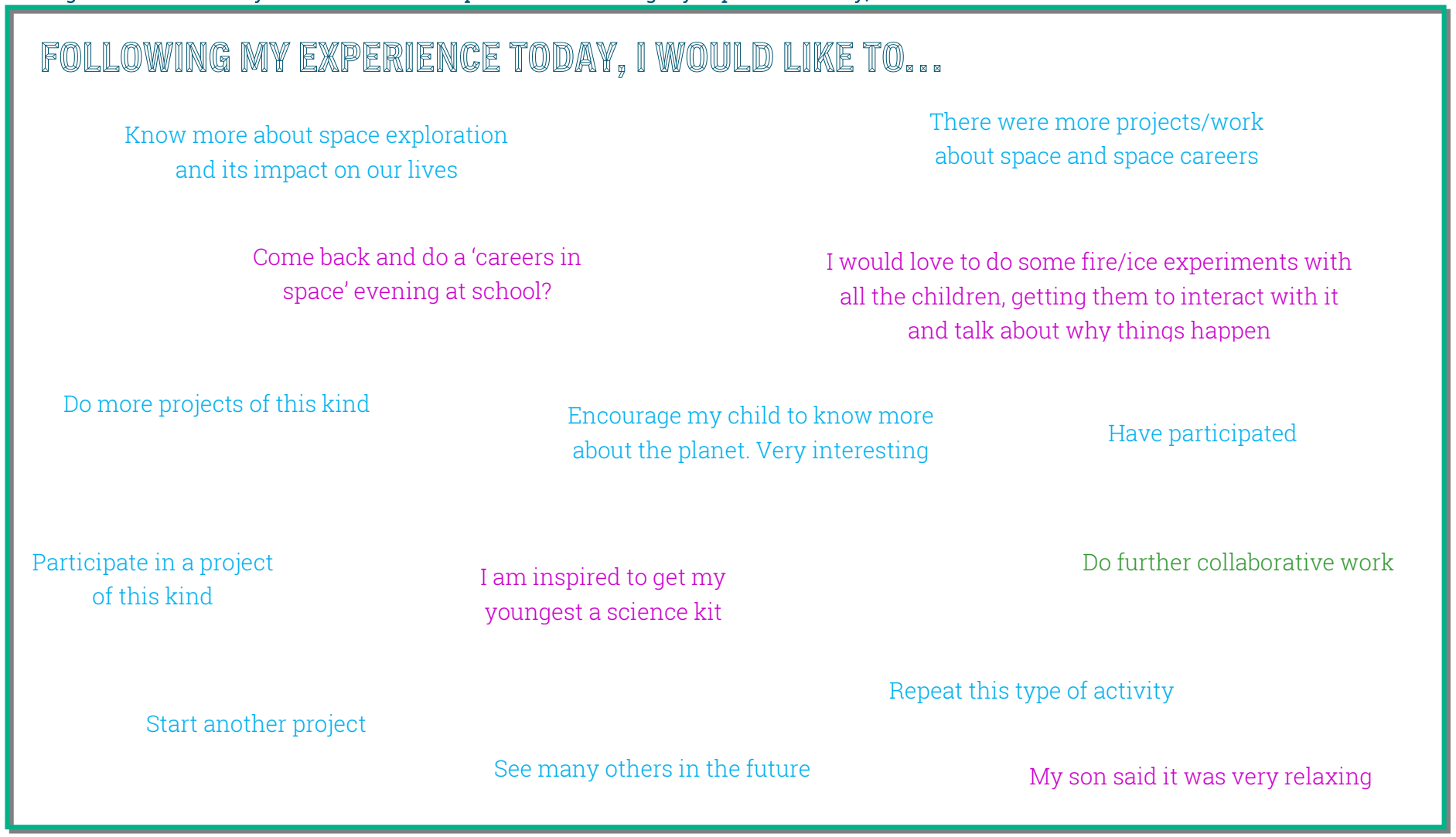
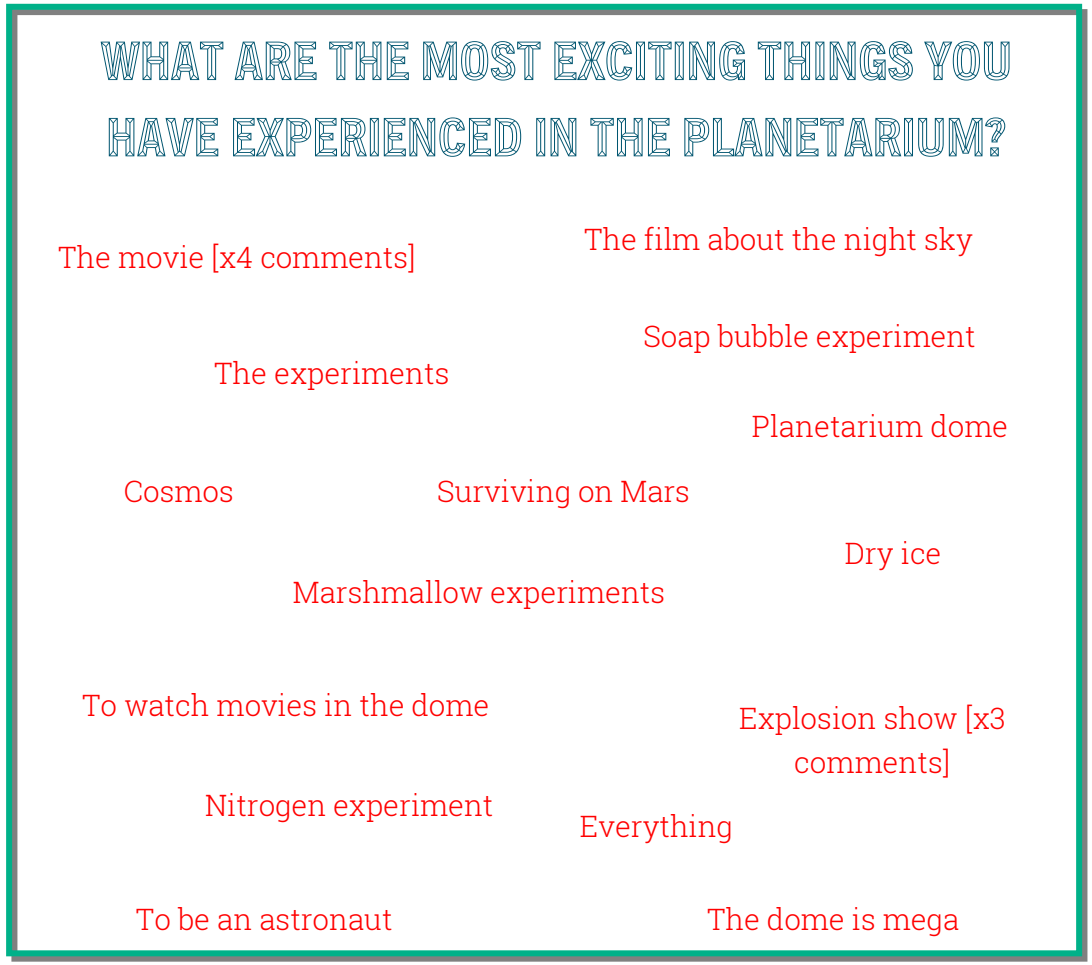


Figure 9 (left)– Community Event Audience Responses to 'at home, my teenager told me about…'
Figure 10 (right) – Community Event Audience Responses to 'what are the most exciting things you have experienced in the planetarium?'



Similar to students' reflections on the Our Space Our Future interventions, the audiences of community events enjoyed being active participants in the events and the opportunity to engage in hands-on activities. Comments from parents were expressive of their enjoyment of observing their child's participation in space-related activities. In Portugal, two parents gave the following responses to the statement, 'today I liked being able to…':

See the joy of the students talking about stars and constellations (Parent/Guardian, Portugal)

See young ones interested in international projects about space (Parent/Guardian, Portugal)

Where community events involved showcasing some of the work students had produced during the interventions, parents often reflected on how impressed they were with the effort and work output that students had produced. This is indicated by the following responses from parents/guardians to the statement 'today, I was surprised to find out that…':

[child's name] never talks about school and he talked about some of the experiences when he got home (Parent/Guardian, England)

How my child commits to the work and likes to know about space. I liked it a lot (Parent/Guardian, Portugal)

Also similar to results from the student interventions were the audience's reflections on their surprise on learning about the variety of careers in the space industry. It was positive to see that many individuals intended to continue their engagement and find out more about careers in the space industry, participate in more science activities at home and look for more projects similar to Our Space Our Future.

The feedback from audiences at the Our Space Our Future community events provide evidence to suggest **GLO P1: members of the public enjoy the Our Space Our Future community events,** was achieved. Given the need to change the format of many community events to coincide with Covid-19 restrictions, and the move to online formats, some of which were asynchronous, the opportunity for public audiences to engage with students was much more limited. Although we have evidence to demonstrate that audiences (parents in particular) valued the opportunity to see their child's work and learn about what activities they had been involved in, we were unable to obtain evidence to confirm whether **GLO P2:**

members of the public engage in conversations with students and ask questions about their work, was achieved or not.

Delivery partner feedback also provided valuable points of learning from implementation that can be used to inform future endeavours and similar education projects, thus providing a legacy to Our Space Our Future. Three distinct learning points were yielded from partners' feedback, relating to what worked well, key challenges and looking to the future. Key points that arose from partners' feedback in relation to these areas are summarised below and where relevant, accompanying quotes from participants of the community event are provided:

What Worked Well?

The question asked to delivery partners: What do you think worked particularly well at the community event? Why?

- The ability to capture high quality video footage of the Our Space Our Future interventions permitted easy dissemination around the school and students' parents. Sharing a simple YouTube link prompted high views among parents and created a great legacy for the school to use in future promotion or events.

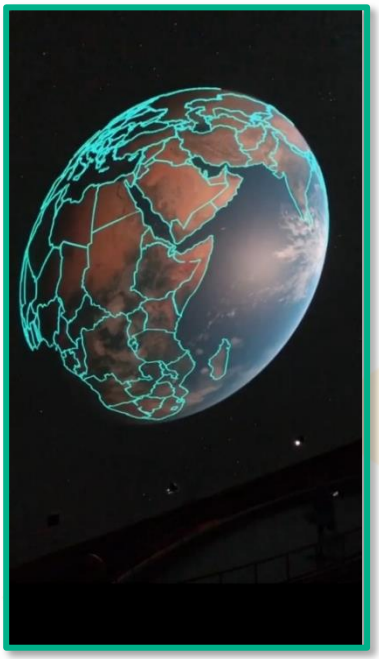
- Having multiple activities for the audience to engage with throughout the event help ensure there is something for everyone. It also encourages continuous interaction, helping events to flow naturally with no 'waiting around'. The Community Event Case #1 provides an example of a community event with a variety of engagement activities for the audience to participate in.

- Events that were open to the wider community and public offered a free event to individuals who may not have otherwise attended such an event. This therefore had the potential to trigger interest and encourage families to seek out additional STEM-related events and activities in the future. See Community Event #1 for evidence of this changed behaviour.

COMMUNITY EVENT CASE #1

Planetarium - Denmark

In Denmark, the team at Planetarium organised a **"family celebration event"** to celebrate the students' participation in the Our Space Our Future project. The event took place at the Planetarium in Copenhagen and all students who participated in the project were invited along with **their siblings, parents and teachers**.



(left) A view from inside the Planetarium in Denmark for one of the Our Space Our Future community events.

(right) a presenter demonstrating what happens in supernova explosions and why we see different colours

Image credits: @ourspaceourfuture, @planetariumcph

The event began with a show titled, 'On the Edge of Darkness' that was projected in the Planetary Dome. The audience then participated in a variety of **science experiments**. The team at Planetarium used dry ice experiments to explain the atmosphere on Mars, used liquid nitrogen to talk about the composition of comets and made "magic" burning soap bubbles to demonstrate how the Earth's atmosphere works and why protective shields on rockets and space suits are so important.

Students engaged in **active dialogue** with the presenters about what was happening in the experiments. One student kept coming back to ask more questions and the mother reported to the presenter how the child had not been very keen to visit the Planetarium but throughout the day he told her how he now found space **"*cool*" and "*awesome*".**

The event finished with 'The Explosive Show' that demonstrated the science behind rockets, shooting stars, supernova explosions and what happened during the Big Bang! There was **something for everyone** at the celebration event, as was demonstrated by the variety of reflections from the audience on the most exciting part of the day (see Figure 10)

- As well as having **multiple activities, variety in these activities** is also important. In particular, including 'hands-on' activities such as experiments and tactile exhibitions, and 'hands-off' activities such as demonstrations and science shows. This permitted the audience to **choose what to engage with and how much** involvement they had. The Community Event Case #2 emphasises the importance of audience autonomy.

COMMUNITY EVENT CASE #2

Science Made Simple - Wales

Point of Impact #1 demonstrated the value of ensuring students are actively involved in their learning, rather than as passive observers. The value of such involvement was also evident from the feedback from Science made Simple's (SMS) community event. The event was titled 'See Seaweed from Space' and took place at a science discovery centre in Wales, UK. The event was organised by SMS in partnership with the Association for Science Education Wales (ASE) and the Institute of Physics Wales (IoP).

The audience had full access to the science centre's hands-on exhibition, experienced a short science show that incorporated aspects of the four student interventions, and activities that students could demonstrate to their families. The event had a large focus on hands-on exploration of science and engineering concepts. SMS explained:

"***Through its playful, collaborative format, the workshop provided alternative learning experiences to traditional classroom approaches… with no specific learning outcomes for students, students could choose how much or how little to do, based on their own confidence levels***".

This approach meant that students had complete autonomy over their engagement and was a key highlight of the event, allowing students to pick and choose what they engaged with as well as how and how much they engaged.

Comments from student participants provided on the graffiti wall at the event were evidence of their appreciation of having autonomy over their experience. In response to the statement, 'today I liked being able to…', students made comments such as ***"try things out"***, ***"try new stuff"*** and ***"have fun and explore new science"***.

- Giving students tasks and responsibilities within the event provided them with a sense of **autonomy and contribution.**

- Placing the focus of the event on the work students had been doing in the Our Space Our Future interventions provided them with a sense of ownership and understanding. This encouraged dialogue between them, their teachers and their families at the event:

> *[child's name] never talks about school and he talked about some of the experiences when he got home* (Parent Response at Community Event, England)

- Where Our Space Our Future was able to include students' **parents** in the project, there was evidence to suggest this had **stimulated conversations around space and science at home**. This is an important finding given the widespread research demonstrating the high influence of parents'/guardians' perceptions and actions on their child's habits and perceptions of norms (Thomas et al. 2020; Ceglie and Setlage, 2016). In one study, 39% of young people reported that family is the most useful source or careers information (Clemence et al. 2013). Therefore, ensuring parents are informed about the importance of space science and the diversity of career opportunities, is an important step forward in influencing the students. An example of parents' involvement in Portugal is provided in **Community Event Case Study #3**.

COMMUNITY EVENT CASE STUDY #3

Nuclio - Portugal

In response to the Covid-19 restrictions and the inability for large school events, Nuclio arranged a blended in-person and online event for one of their schools. The event involved a **student-led exposition about different space careers.** Students created posters on the different space careers and generated a QR code that led people to a short video, created by the students to explain more about these particular careers. The exposition took place in the school library and stayed there for a week to allow other students within the school to visit and **learn from their** peers about space careers.

Although parents and families were unable to visit the exposition, to ensure their involvement, **a movie of the exposition was created and disseminated to all parents**.

Although the Nuclio team believed the event benefited students the most, they felt "***it was also very important for parents to have been able to see the work of students***".

This importance was evident from the feedback from the parents themselves. When responding to the graffiti wall statements, parents appreciated the opportunity to view the work their children had carried out and to see what they had been learning about in school. One parent commented: today I was surprised to find out "***how my child commits to the work and likes to know about space***". Another commented: today I was most impressed by "***the innovative ideas of the students***".

However, multiple parents also emphasised how they themselves had gained new understanding and highlighted that they had been unaware of the variety of space careers available. One parent commented: today I was surprised to find out "***there are lots of professions related to space that I didn't know of***".

It was also promising to see that parents intended to further their own understanding as well as sustain their children's interest and curiosity in space in the future. For example, two parents commented: following my experience today, I would like to "***encourage my child to know more about the planet.***" and "***know more about space exploration and its impact on our lives***"

Challenges Faced and Overcoming Them

The question asked to delivery partners: **What was the biggest challenge of the community event? How did you overcome this?**

- One of the biggest challenges faced in delivering the community events was organising an event that complimented the original objectives and was possible within the confines of the Covid-19 restrictions that influenced the scale of events and delivery format:

The biggest challenge was finding a format that allowed us to have some direct contact with all or any parties, in-keeping with the Covid restrictions in place at the time. (Science Made Simple, Wales Delivery Partner)

- Adaptations to the original plans for community events meant **additional skills were required among delivery partners** that were less familiar to them. This typically involved photography and filming, video-editing and online delivery of content designed for in-person delivery.

- Permission and **consent for photography** with students was difficult to obtain and involved a lot of administrative work. There were also occasions where specific permissions limited the level of dissemination of video footage and photographs.

- **Capturing evaluation/feedback data from participants was a challenge** and delivery partners reported difficulty in getting responses. Some difficulty in this had been anticipated due to the need for a standard evaluation framework and strategy for implementation across a variety of events and formats. What embedded well in some events, did not work so well in others. This was complicated further when delivery had to be adapted in response to the pandemic regulations:

We set up the Mentimeter at a visible place where most participants would pass by, but in the context where presenters were showing experiments, it seemed that participants found it less interesting to take out their phones, access the Mentimeter website, insert a code and add their input. They would rather interact with the presenters' activities with science experiments (Planetarium, Denmark Delivery Partner)

- **Promotion and marketing of community events** was challenging for some delivery partners. Organisation alone of the events was challenging due to the continuously changing landscape and regulations of the Covid-19 pandemic. As

a result, there were many changes in dates, locations and modes of delivery (in-person/online). Due to such uncertainties, delivery partners were limited in the time they had to promote events. Some events also had to be confined to lower numbers due to restrictions and therefore limited the audience reach.

Looking to the Future

The question asked to delivery partners: **If you were to run the community event again, what would you add, remove or do differently? Do you have any advice or recommendations you would give to an organisation looking to run a similar event?**

- Delivery partners reported a desire to have run the community events in the formats that were initially planned, however, in future would recommend ensuring there are appropriate back-up plans in place.

- Some community events were delivered asynchronously online to audiences. Similar to the previous point, additional planning and preparation would have been advantageous in **implementing a more immersive, synchronous (live), two-way engagement event**. Had delivery partners known that some events would have to run in this format, they would have set up a private Facebook/Teams/Zoom event with a day dedicated to sharing activities with the audience. This would have enabled greater interaction and discussions between the delivery partners and their audiences.

- Some delivery partners saw value in **hiring professionals dedicated solely to photography and filming.** This would leave presenters to focus all their attention on the audience and on delivery.

- Where in-person events had to be transformed into online events, partners reflected how they would have liked to **have given more ownership to the students in creating their own 'event'**: the aim of the event, how it would run, and who would attend:

> *If it is a virtual event, it was good to let the students choose the way they wanted to share their work with the community but [in future, we would] introduce the students to digital tools and let them find a way to create their "event"* (Nuclio, Portugal Delivery Partner)

- Delivery partners expressed they would **place greater emphasis on embedding evaluation** data collection within the delivery of events.

Our Space Our Future Webinars

In response to the pandemic and a limitation on the scale of the Our Space Our Future community events, a series of webinars were organised to further engage with student, teacher and parent audiences as well as the wider public.
These events are described in detail in Deliverable 6.3. However, some of the evaluation data that was captured from these events is also described here.

An online survey was circulated to the webinar audiences following the events to capture some feedback around audience experiences. This was done following two webinars: 'Interest is not Enough', which focused on how educators and science communicators talk about the space industry and how we can shift individuals' general interest in relevant subjects into an aspiration towards relevant careers, and 'Universally Different', which explored alternative methods of teaching and communicating STEM and space topics in order to promote inclusive and accessible practices in STEM education.

Follow-up engagement in evaluation is notoriously difficult to capture, however we did receive 16 responses from a total of 63 attendees. These 16 respondents represented a variety of roles (individuals could tick more than one), including: students, parents, teachers/educators, STEM communicators, space industry professionals, individuals with a passion for STEM and/or space, and researchers. Some respondents omitted some questions from the survey.

Of the 15 respondents who provided answers, 11 stated that they plan to attend another Our Space Our Future online event in the future (the remaining four participants indicated 'maybe', one participant did not respond). Similarly, 12/16 respondents said they would recommend the Our Space Our Future online events to others (again the remaining four participants indicated 'maybe).

Respondents were asked to rate their overall experience, the usefulness of the event and the suitability of the content on a 10-point scale. Means of the total results are presented in Table 18.

Table 18 – Audience Experiences of Our Space Our Future Webinars

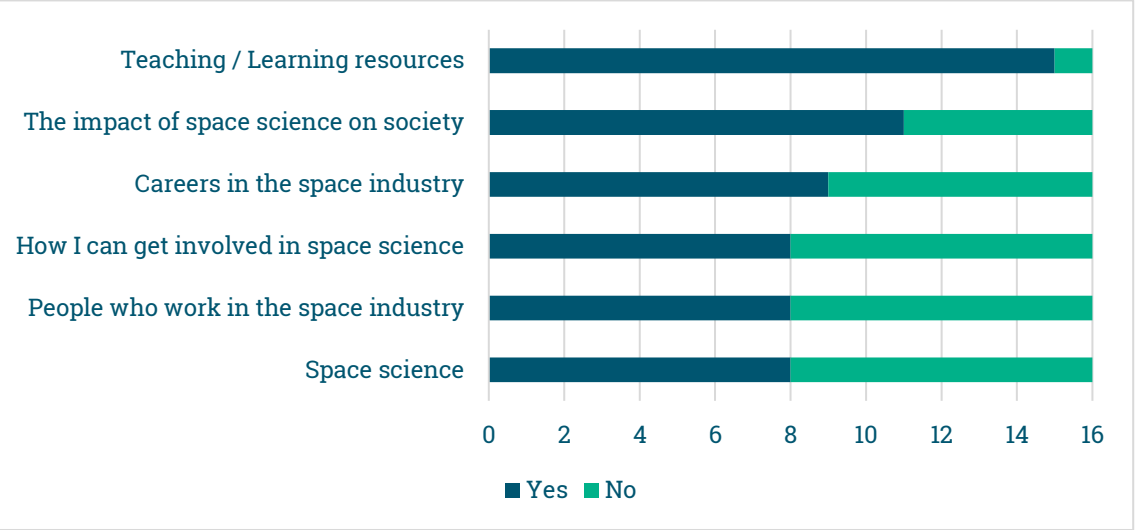
On a scale of 1 to 10...	Scale	Mean
How would you rate your overall experience of the OurSpace online event?	1 = awful 10 = excellent	8.7
How useful did you find the OurSpace online event to you personally?	1 = not at all useful 10 = extremely useful	8.2

How would you rate the suitability of the content delivery?	1 = too basic 5 = just right 10 = too complicated	7.1*

*A score of 5 is the optimum score for this question, whereas a score of 10 is the optimum score for the other two questions

Participants were asked on a dichotomous 'yes/no' scale whether they 'had learnt anything' in a number of areas. Results to these questions are presented in Figure 11. In all areas, at least half (n=8) of participants indicated 'yes'. The most positive results were captured for learning about new 'teaching / learning resources' and 'the impact of space science on society'. These are expected findings given the topics of the two webinars that participants had attended.

Figure 11 – Did you learn anything in the following areas? Results from a survey sent in follow-up of webinars



Summary of Public Results

- Public audiences **enjoyed being active participants** in community events with opportunity to engage in **hands-on activities.**
- Parents were expressive of their **enjoyment of observing their child's participation** and engagement in space-related activities.
- Public audiences reflected on their **surprise in learning about the variety of careers in the space industry.**
- **Public audiences** provided feedback to indicate they **would like to continue their engagement with space-related activities in the future**.
- Generic Learning Outcomes achieved:
    - **P1: Members of the public enjoy the community events**
- Generic Learning Outcomes without evidence:
    - **P2: Members of the public engage in conversations with students and ask questions above their work**

CONCLUSION

Our Space Our Future set out with **an aim to enable and empower all students, regardless of gender, ethnicity, disability or socio-economic background, to consider a career related to space science as a relevant, attainable and exciting aspiration for their future.**

The onset of the **Covid-19 global pandemic was a substantial challenge** to the Our Space Our Future project. School closures, shifts to remote learning and social distancing regulations meant that the format of interventions had to be adapted and some activities simply could not be delivered. This is an important context that cannot be ignored when interpreting the evaluation data from the project.

The success of Our Space Our Future in meeting its generic learning outcomes has been described throughout the report. It was apparent in some cases, we were unable to obtain sufficient evidence to indicate whether or not these had been achieved. To summarise the extent to which GLOs were achieved, Table 19 details the GLOs for each audience group and provides four possible categories: achieved, partially achieved, not achieved and no evidence.

Table 19 – Summary of Generic Learning Outcomes and Extent of Achievement

GLO	Description	Achieved
Enjoyment, Inspiration and Creativity	S1: Diverse groups of students feel greater enjoyment when doing science	Achieved
	S2: Diverse groups of students enjoy learning about space science	Achieved
	T1: Teachers find the OurSpace CPD content inspiring	Achieved
	T2: Teachers find the OurSpace CPD sessions useful to their classroom practice	Achieved
	P1: Members of the public enjoy the OurSpace community events	Achieved
Attitudes and Values	S3: Diverse groups of students perceive space science to be accessible to them	Partially Achieved
	T3: Teachers feel that the CPD content engages their students	Achieved
	T4: Teachers regard space science as applicable to all students	Partially Achieved
Behaviour and Progression	S4: Diverse groups of students want to learn more about space science	Achieved
	S5: Diverse groups of students want to learn more about careers in space science	Partially Achieved
	S6: Diverse groups of students consider pursuing a career in space science	Not Achieved
	T5: Teachers bring space science into their classroom	Partially Achieved/Limited Evidence
	T6: Teachers use the strategies they learnt in the CPD in their classroom	Partially Achieved/Limited Evidence
	T7: Teachers inform students of career opportunities in space science	Partially Achieved/Limited Evidence
	T8: Teachers are encouraged to promote a more student-centred classroom	Partially Achieved
	P2: Members of the public engage in conversations with students and ask questions about their work	No Evidence
Knowledge and Understanding	S7: Diverse groups of students understand the importance and value of space science in society	Achieved
	S8: Diverse groups of students recognise the diversity of people who work in the space industry	Achieved
	S9: Diverse groups of students recognise the relevance of space science to environmental issues	Achieved
	T9: Teachers know how to apply space science as a context in the science classroom	Partially Achieved
	T10: Teachers understand how space science can be applied to their classroom through real-life examples	Achieved

Table 19 illustrates that work package 5 was able to obtain evidence to indicate that **11 out of the 21 GLOs were achieved** for Our Space Our Future. **Eight GLOs were partially achieved**, although three of these had limited evidence, and **one was not achieved**. For one GLO we were unable to collect any evidence to indicate whether or not it had been achieved.

The achievement or partial achievement of **19 out of the 21 generic learning outcomes** is considered to be a huge success. This is particularly so when we consider the context of the substantial challenges of implementing a large-scale, international education project during a global pandemic, whereby much of the Our Space Our Future programme could not be implemented as initially envisaged.

The Our Space Our Future interventions generated an **increase in the proportion of students with positive attitudes** towards 12 out of the 14 survey statements relating to interest, relevance, accessibility, possible selves and future aspirations. Subsequent to the implementation of Our Space Our Future, **85.8% of students reported that space science is interesting, 85.3% agreed that people from different countries work in space science, and 81.0% felt discoveries in space science were important to society**. Following student interventions, the proportion of students who agreed that discoveries in space science make our lives easier had increased by 13.6%, and the proportion of students who agreed that all kinds of different people work in the space science industry increased by 10.2%. An area of substantial impact was also seen in **promoting the diversity of the space industry and the variety of potential career pathways**. Often students' reflected that they had not known so many different careers existed.

The multiple intervention approach of Our Space Our Future and delays due to the pandemic, meant that more than a year had passed between when students completed the baseline survey and when they completed the post-interventions survey. Given this time period where any short-term enthusiasm and excitement of sheer novelty of the Our Space Our Future programme would have diminished, we can be confident that such results are indicative of **long-term attitudinal change towards space science among our student audience.**

The impact evaluation has also provided some key learning points from the project. These are not only beneficial to the delivery partners of Our Space Our Future but to all STEM educators and communicators. Students' **learning experiences and enjoyment are promoted when they are provided with opportunity for active participation and autonomy in their learning,** rather than as passive observers. Where delivery partners were able to involve students' parents in community events, it was evident that often, **parents were unaware of their child's interest in space and the work they had been doing**. Some parents also expressed their

intentions to continue participating in space-related activities and finding other similar projects. This is an important finding in the context of sustaining the legacy of Our Space Our Future.

The area in which Our Space Our Future struggled to have impact was on students' future aspirations and desire to pursue a career in the space industry. It was apparent that even on recognising the variety of career opportunities, the space industry was still perceived by students to be a daunting career path that is dangerous, high pressured and requires you to be away from family. However, positive impact was evident among students in England. Explorer Dome provided valuable insight in how we might be able to expand students' attitudes from one of interest, to one of aspiration. Explorer Dome emphasised the importance of knowing your student audience and the value of identifying their interests and drawing connections with space. This helps students to identify the role they could play in the space industry. Introducing students to industry professionals that could act as role models was a successful activity for multiple delivery partners and helped students to recognise the diversity of roles and the type of people who work in the industry. The importance of making these individuals relatable and not too dissimilar from the students is important in fostering students' sense of capability. Although it is evident that students' engagement with these role models was a positive experience, it is considered that these interactions could have been even more beneficial had they been in-person interactions. Students typically engaged with these role models online which could arguably still present a sense of distance and disconnect between the students and these individuals. Had it been possible to have in-person interactions with these role models, there is a possibility Our Space Our Future would have seen greater increase in students' perceptions of their possible selves and their beliefs that space science and STEM is 'for them'.

Nonetheless, this perception of science being 'for them' was promoted through how delivery partners framed science. Instead of portraying science as a subject full of facts and answers, shifting the narrative to one where science is about asking questions and not being afraid to fail can help to empower students to see science as 'for them'.

Although more work is needed to encourage students to pursue careers in space, the findings from Our Space Our Future are evidence that progress is being made, and evidence of good practice has been obtained.

Teachers who participated in the Our Space Our Future CPD events reported positive intentions to use the materials and techniques in their teaching. Given the shift in the timeline of Our Space Our Future, and delays faced in implementation due to the pandemic, for the majority of teachers, we were only able to capture their

feedback immediately after attending their CPD event. However, we were able to follow-up with teachers in Denmark in order to explore what teaching practices they had since implemented.

It was promising to learn that **teachers found the CPD sessions to be inspiring, of benefit to their students and of use to their own and their colleagues' teaching**. Generally, having completed the CPD session, **teachers intended to include space-related classroom activities more frequently in their teaching**. The data collected from teachers in Denmark several months after the CPD event, although small in number, provided encouraging feedback on the **value and applicability of the CPD content to classroom practice**, and teachers reported having used the Our Space Our Future techniques.

The **majority of teachers perceived the Our Space Our Future CPD content to be applicable to diverse student groups**. Nonetheless, there was greater certainty around the applicability to high ability students and greater uncertaintly around the applicability to students of lower ability, of low socio-economic background, of ethnic minority backgrounds and with special educational needs. Although many reflected that the content could be suitably adapted for use in all student groups, this was not a unanimous view and clearly, **more work in this area would be beneficial.** It is also important to consider these results in parallel to the student results from schools in England. Here, the England delivery partner, Explorer Dome induced an increase in students' attitudes across all survey statements and these schools were among some of the most underserved across the programme and presented the largest proportion of special educational needs and disabilities. These results are therefore **suggestive that Our Space Our Future resources and techniques are in fact more suited to and have greater impact on students of lower ability and lower socio-economic status than is implied from the teacher data.**

Community and public events were largely effected by the pandemic, however where we were able to collect evaluation data, it was apparent that **public audiences appreciated the opportunity to engage in a variety of different activities** and mediums of learning. Similar to students, the public audiences reflected on their surprise in learning about the variety of career opportunities in the space industry. Reflections from parents around their enjoyment of seeing their child engage in space science is suggestive that Our Space Our Future could have had greater impact, had the community events been able to go ahead as initially planned.

Although much of the Our Space Our Future programme could not be implemented as envisaged, the data collected in work package 5 has demonstrated the positive impact of Our Space Our Future. Not only were we able to quantify this impact but qualitative and contextual data enabled us to capture valuable information around

particular audiences' experiences that led to this impact, as well as reveal areas of good practice. As a result, **Our Space Our Future has yielded a number examples of good practice and lessons learned that will be of great value for STEM educators and communicators** who embark on future education programmes.

REFERENCES

Ametller J. and Ryder J. 2014. The Impact of Science Curriculum Content on Students' Subject Choices in Post-Compulsory Schooling. In: Henriksen, E., Dillon, J. and Ryder, J. (Eds). *Understanding Student Participation and Choice in Science and Technology Education*, pp. 103-118. London: Springer.

Archer L., DeWitt J., Osborne J., Dillon J., Willis B., and Wong B. 2010. "Doing" Science Versus "Being" a Scientist: Examining 10/11-year-old schoolchildren's constructions of science through the lens of identity. *Science Education* 94(4), pp.617-639. DOI: 10.1002/sce.20399

Archer L., Osborne J., DeWitt J., Dillon J. and Wong B. 2013. ASPIRES: *Young People's Science and Career Aspirations, Age 10-14*. Available at: https://www.raeng.org.uk/RAE/media/Grant-applications-and-guidelines/ASPIRES-final-report-December-2013.pdf [Accessed: 20 May 2022]

Archer L., Moote J., MacLeod D., Francis B., DeWitt J. 2020. *ASPIRES 2: Young People's Science and Career Aspirations, Age 10-19*. Available at: https://discovery.ucl.ac.uk/id/eprint/10092041/15/Moote_9538%20UCL%20Aspires%202%20report%20full%20online%20version.pdf [Accessed: 20 May 2022]

Ardies J., Maeyer SD., Gijbels D. and van Keulen H. 2014. Students' Attitudes Towards Technology. *International Journal of Technology and Design Education* 25, pp. 43-65. DOI: 10.1007/s10798-014-9268-x

Barton A.C., Tan E., and Greenberg D. (2017) *The Makerspace Movement: Sites of Possibilities for Equitable Opportunities to Engage Underrepresented Youth in STEM, Teachers College Record* 119(6), pp. 1-144. Available at: https://www.tcrecord.org/library/Abstract.asp?ContentId=21785 [Accessed: 20 May 2022]

CEDFOP (European Centre for the Development of Vocational Training). 2014. *Rising STEMS*. Available at: https://www.cedefop.europa.eu/en/data-insights/rising-stems [Accessed: 20 May 2022]

Ceglie RJ. And Setlage J. 2016. College Student Persitence in Scientific Disciplines: Cultural and Social Capital as Contributing Factors. *International Journal of Science and Mathematics Education* 14(1), pp. 169-186

Cleaves A. 2005. The Formation of Science Choices in Secondary School, *International Journal of Science Education* 27(4), pp.471-486

Clemence M., Gilby N., Shah J., Swiecicka J., Warren D. et al. 2013. *Wellcome Trust Monitor Wave 2: Tracking public views on science, biomedical research and science education*. Available at: https://wellcome.org/sites/default/files/monitor-wave2-full-wellcome-may13.pdf [Accessed: 22 May 2022]

Cohen J. 1988. *Statistical Power Analysis for the Behavioral Sciences*. 2nd Edition. New Jersey, US: Lawrence Earlbaum Associates

Dawson E., Archer L., Seakins A., Godec S., DeWitt J., King H., Mau A. and Nomikou E. 2019. Selfies at the Science Museum: exploring girls' identity performances in a science learning space. *Gender and Education* 32(5), pp.664-681. DOI: 10.1080/09540253.2018.1557322

DeWitt J. and Bultitude K. 2018. Space Science: The View from European School Students. *Research in Science Education* 50, pp. 1943-1959. DOI: 10.1007/s11165-018-9759-y

Dodd J. 2009. The Generic Learning Outcomes: A Conceptual Framework for Researching Learning in Informal Learning Environment. In: Vavoula G, Pachler N. and Kukulska-Hulme A. Eds. *Researching Mobile Learning: Frameworks, Tools and Research Designs*. Germany: Peter Lang. pp. 221-241

European Commission. 2021. *Special Eurobarometer 516 European Citizens' Knowledge and Attitudes towards Science and Technology*. Available at: https://europa.eu/eurobarometer/surveys/detail/2237 [Accessed: 20 May 2022]

Horizons in Physics Education (HOPE). 2016. *Horizons in Physics Education: Final Report*. Available at: http://www.hopenetwork.eu/content/hope-final-report [Accessed: 20 May 2022]

Jenkins EW. And Nelson NW. 2005. Important but not for me: Students' attitudes toward secondary school science in England. *Research in Science & Technological Education* 23, pp. 41-57. DOI: 10.1080/02635140500068435

Jones H., Yeoman KH. And Cockell CS. 2007. A Pilot Survey of Attitudes to Space Science and Exploration among British School Children. *Space Policy* 23(1), pp. 20-23. DOI: 10.1016/j.spacepol.2006.11.013

Lee K., Gjersoe N., O'Neill S. and Barnett J. 2020. Youth Perceptions of Climate Change: A narrative synthesis, *WIREs Climate Change* 11(3). DOI: 10.1002/wcc.641

Markus, H. and Nurius, P. (1986) Possible Selves, *American Psychologist* 41(9), pp. 954-969.

Muller C., Illingworth S., Leigh R.R., Trent T. et al. (2013) The Blue Marble: A model for primary school STEM outreach, *Physics Education* 48(2). DOI: 10.1088/0031-9120/48/2/176

Murray R. 2016. *Unlocking Europe's Potential via STEM Education*. Microsoft EU Policy Blog. Available at: https://blogs.microsoft.com/eupolicy/2016/11/24/unlocking-europes-potential-via-stem-education/ [Accessed: 20 May 2022]

Organisation for Economic Cooperation and Development (OECD). 2006. *Global Science Reform: Evolution of Student Interest in Science and Technology Studies Policy Report*. Available at: https://www.oecd.org/science/inno/36645825.pdf [Accessed: 20 May 2022]

Osborne J., Simon S., and Collins S. 2003. Attitudes Towards Science: A review of the literature and its implications. *International Journal of Science Education* 25(9) pp.1049-1079. DOI:10.1080/0950069032000032199

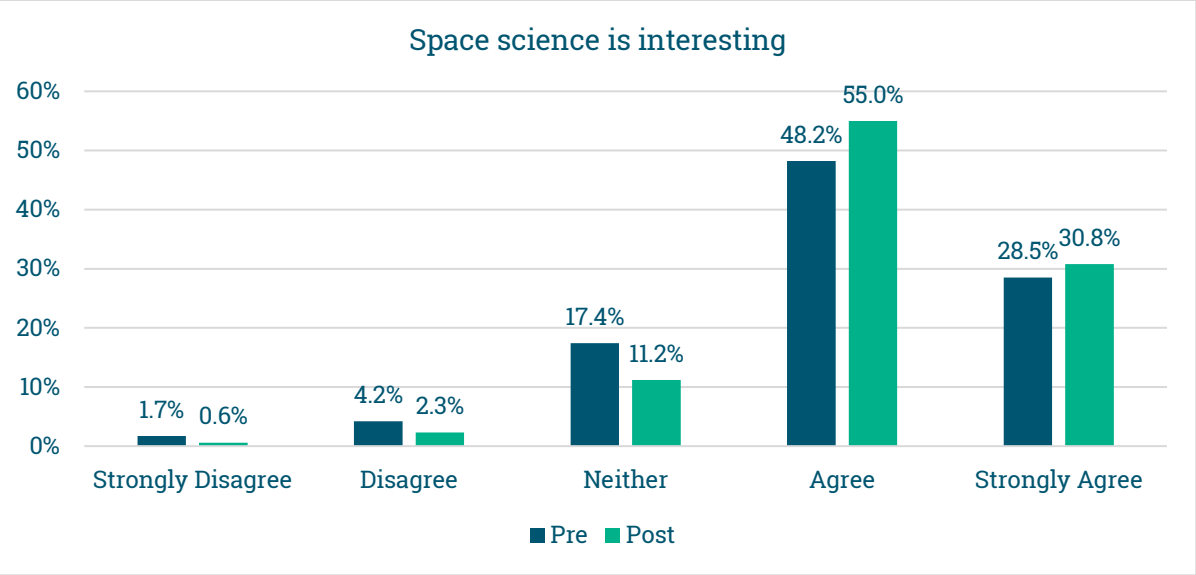
Rodd M., Reiss M. and Mujtaba T. 2014. Qualified But Not Choosing STEM at University: Unconscious Influences on Choice of Study, *Canadian Journal of Science, Mathematics and Technology Education* 14(4), pp. 330-345. DOI: 10.1080/14926156.2014.938838

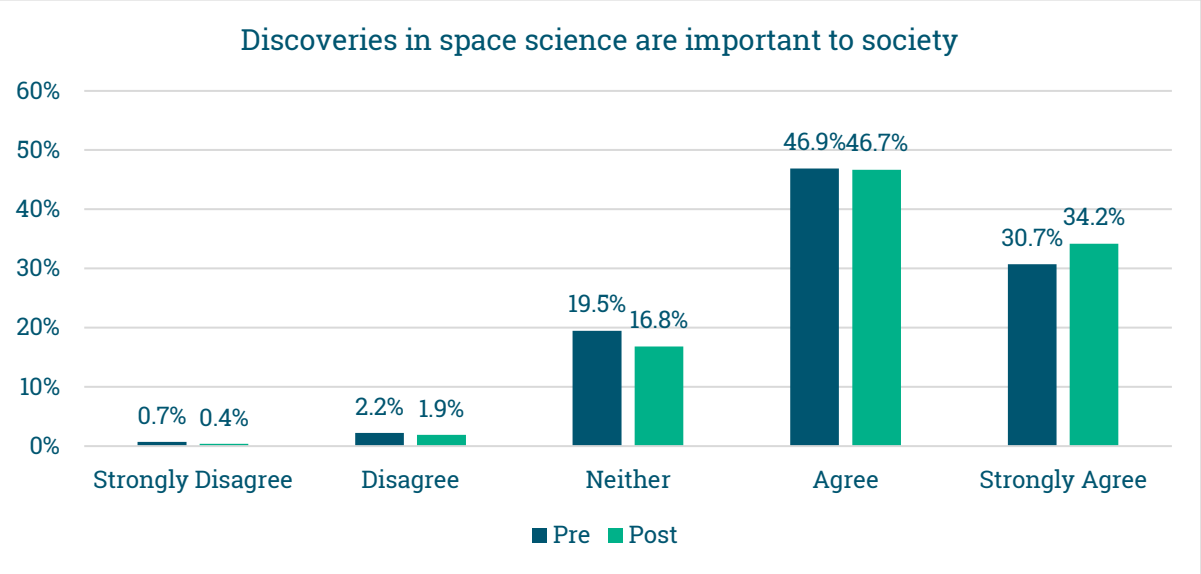
Sjøberg S. and Schreiner C. 2010. *The ROSE Project: An overview and key findings*. Oslo: University of Oslo

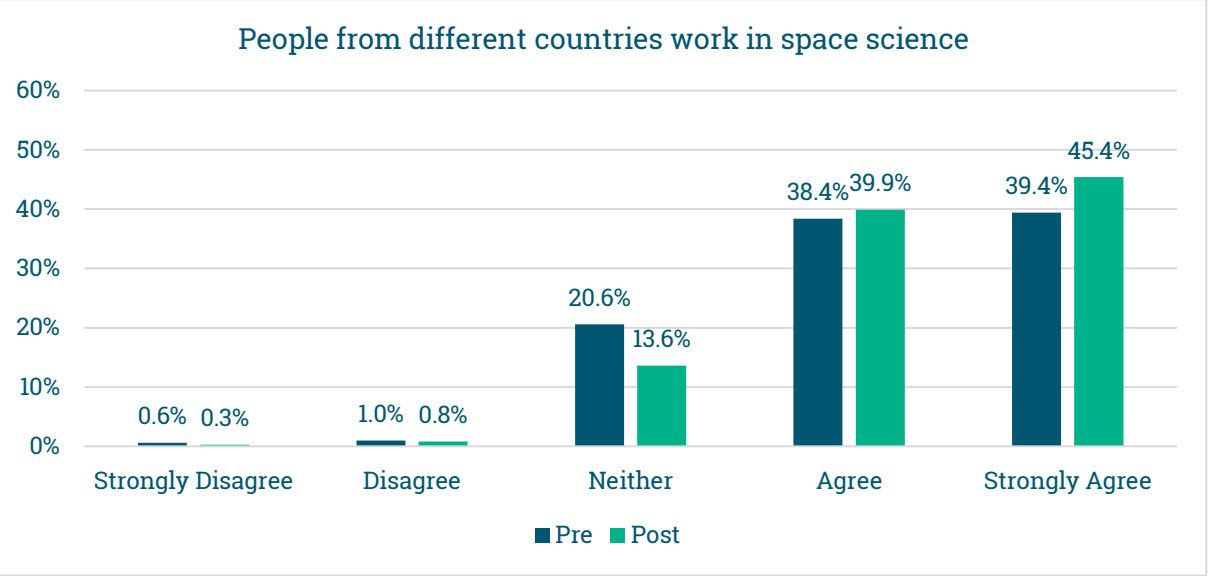
Thomas JA., Utley J., Hong S., Korkmaz H. and Nugent G. 2020. Parental Influence on STEM Learning: a review of the research. In: Johnson C., Mohr-Schroeder MJ, Moore TJ. And English LD. Eds. *Handbook of Research on STEM Education*. New York: Routledge/Taylor & Francis Group.

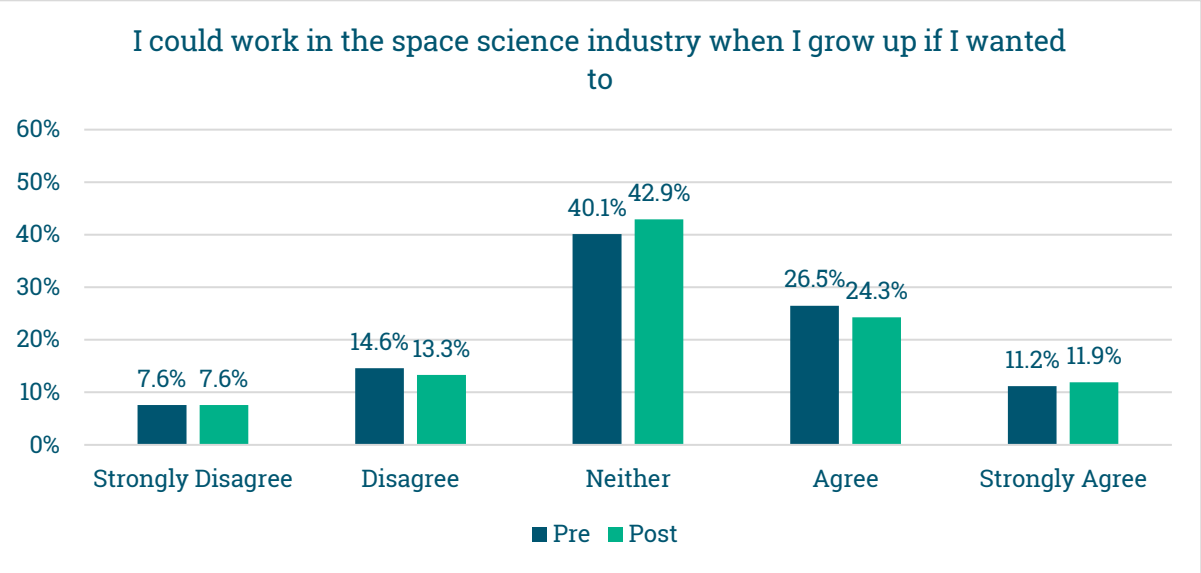
APPENDICES

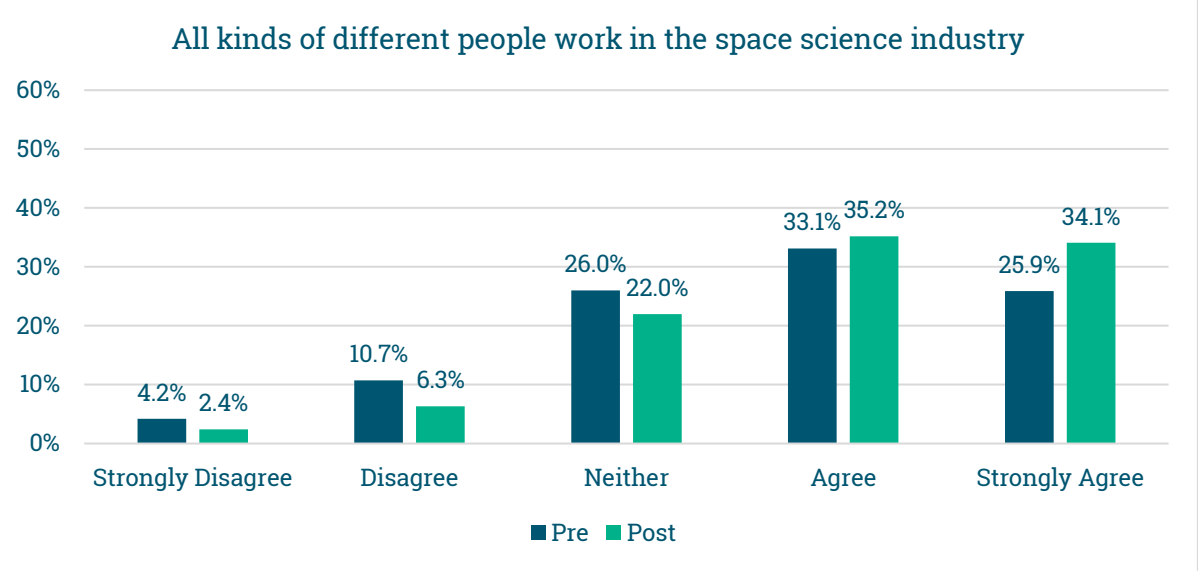
Appendix 1 – Distribution of Students' Responses to Survey Statements, Pre- and Post-Interventions

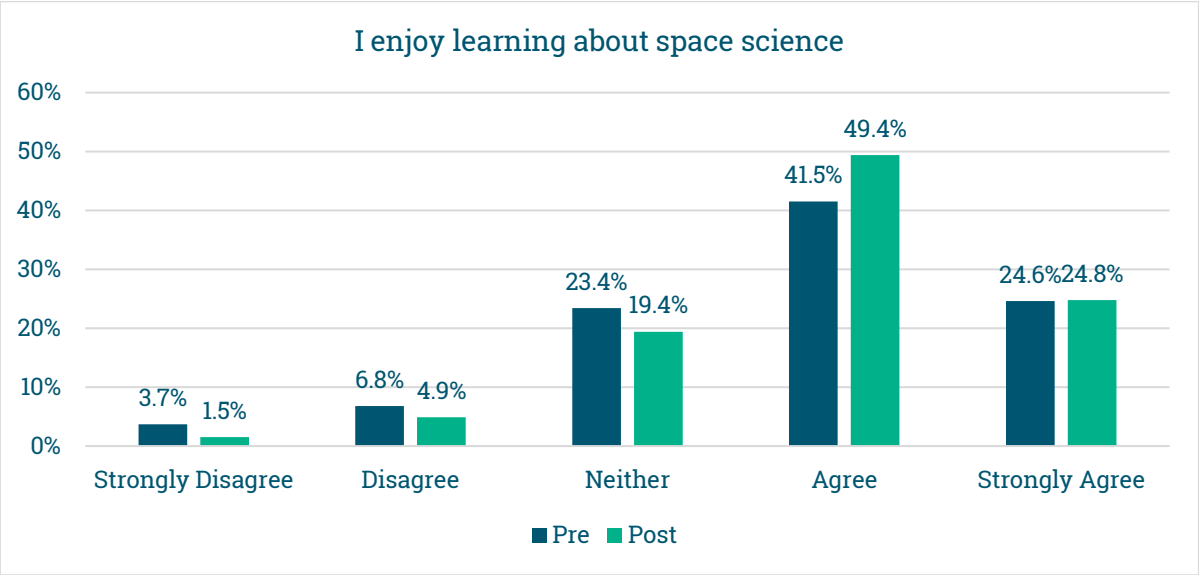


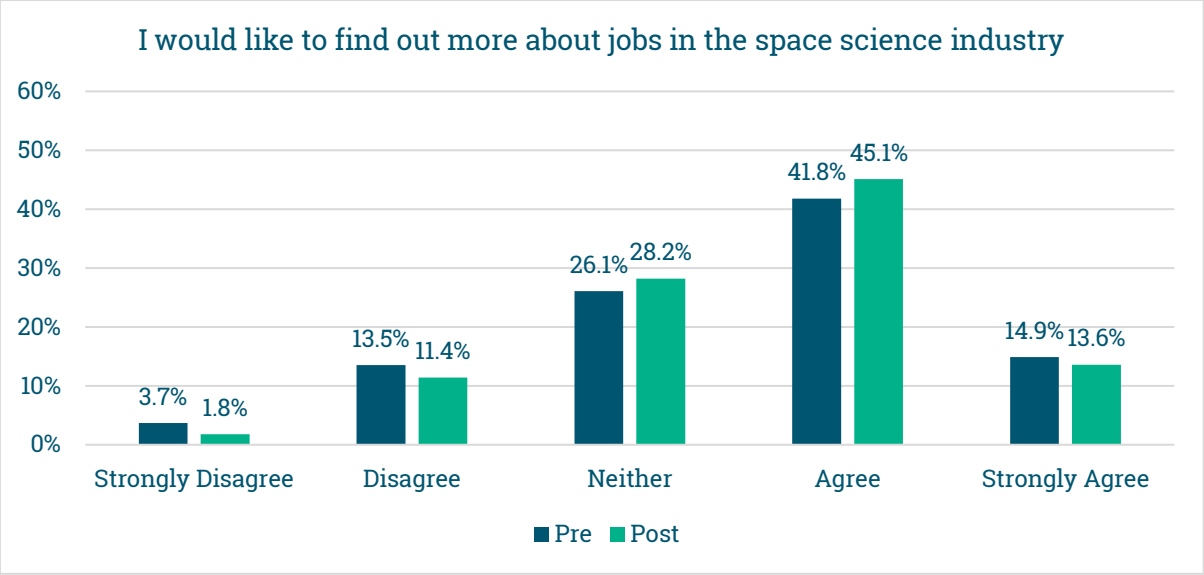


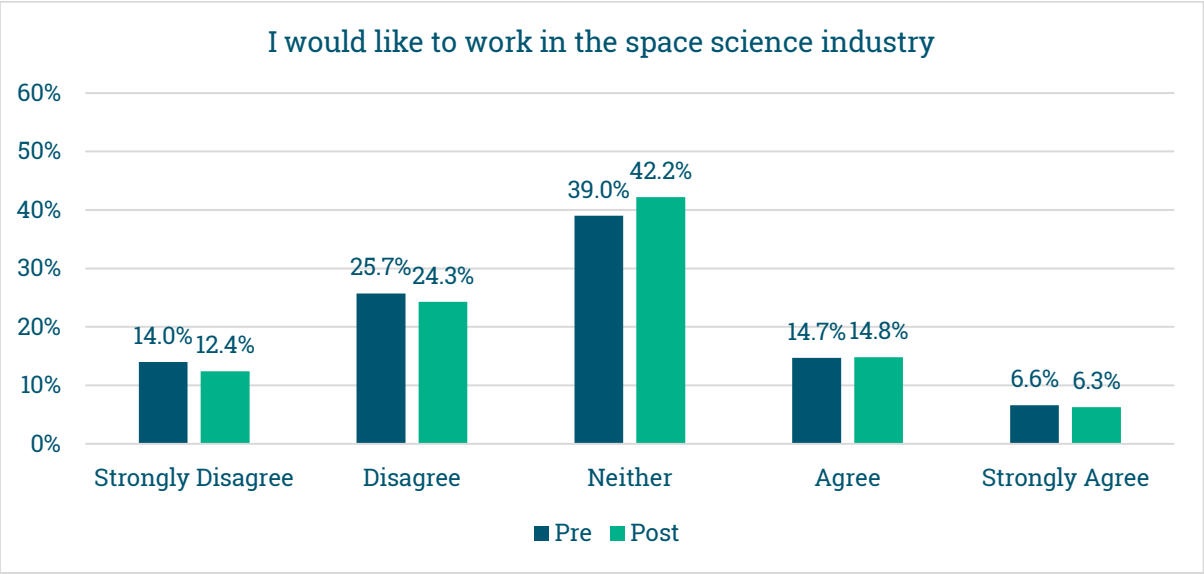

People from different countries work in space science
60%
50%
40%
30%
20%
10%
0%
0.6%
0.3%
1.0%
0.8%
20.6%
13.6%
38.4%
39.9%
39.4%
45.4%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post

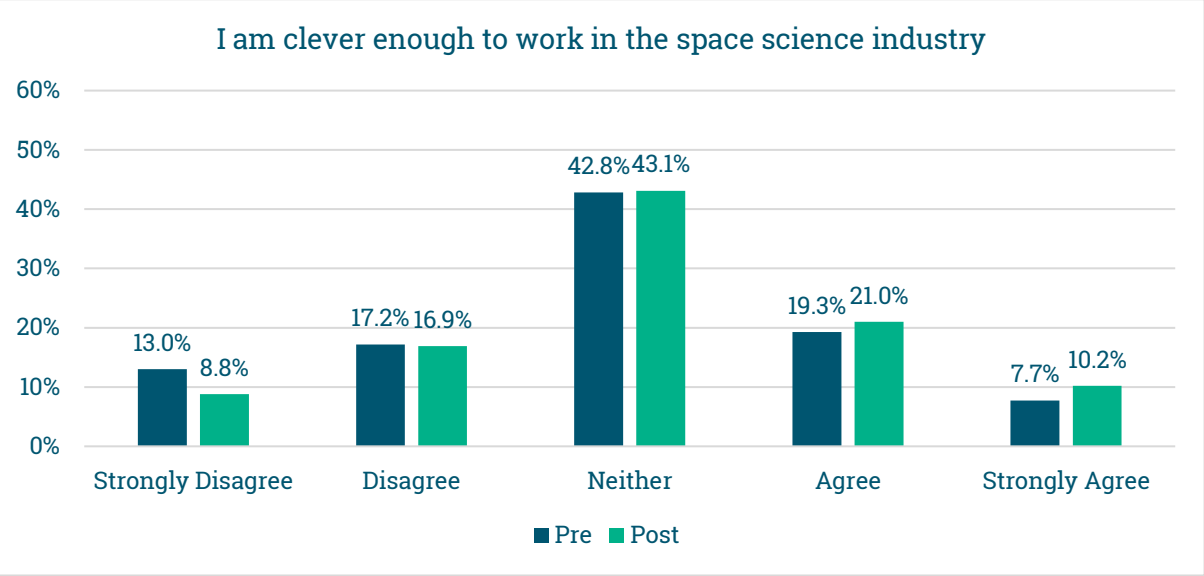

I could work in the space science industry when I grow up if I wanted to
60%
50%
40%
30%
20%
10%
0%
7.6%
7.6%
14.6%
13.3%
40.1%
42.9%
26.5%
24.3%
11.2%
11.9%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post

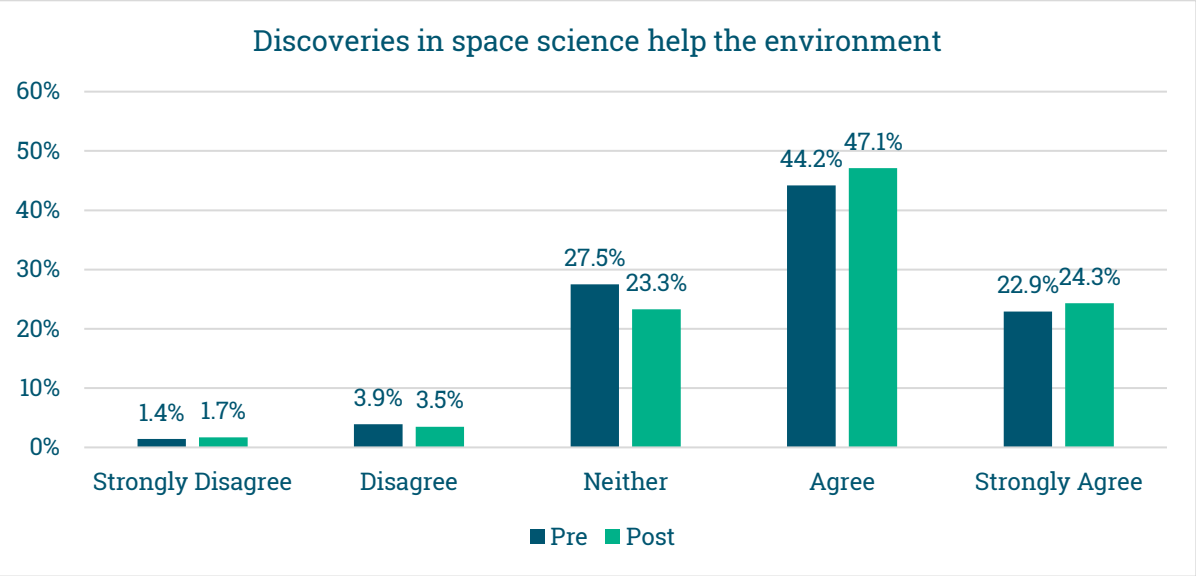

All kinds of different people work in the space science industry
60%
50%
40%
30%
20%
10%
0%
4.2%
2.4%
10.7%
6.3%
26.0%
22.0%
33.1%
35.2%
25.9%
34.1%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post

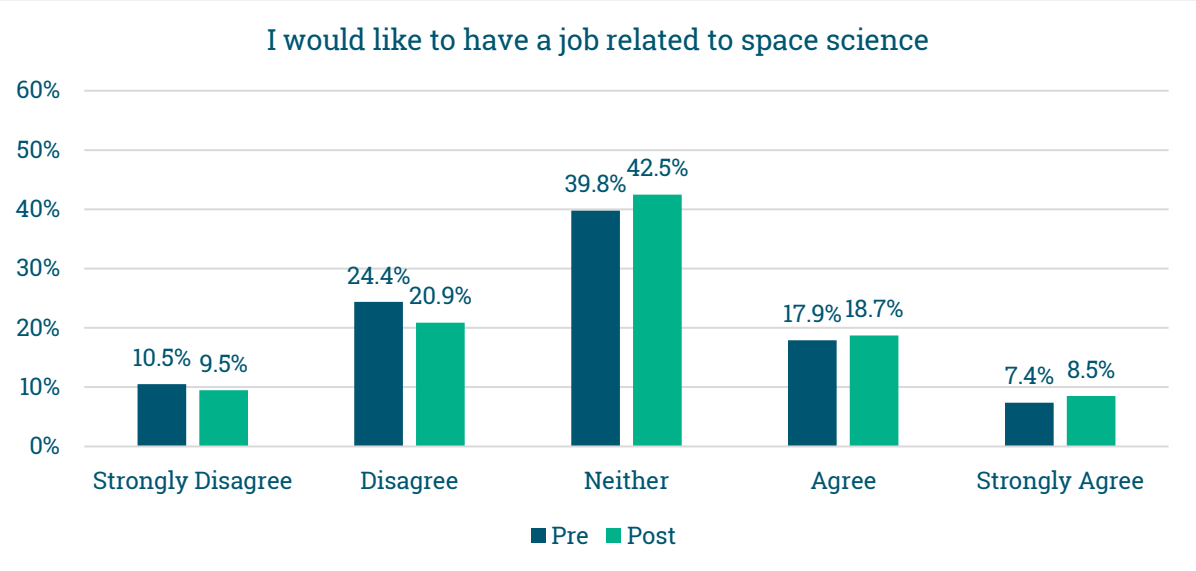

I enjoy learning about space science
60%
50%
40%
30%
20%
10%
0%
3.7%
1.5%
6.8%
4.9%
23.4%
19.4%
41.5%
49.4%
24.6%
24.8%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post

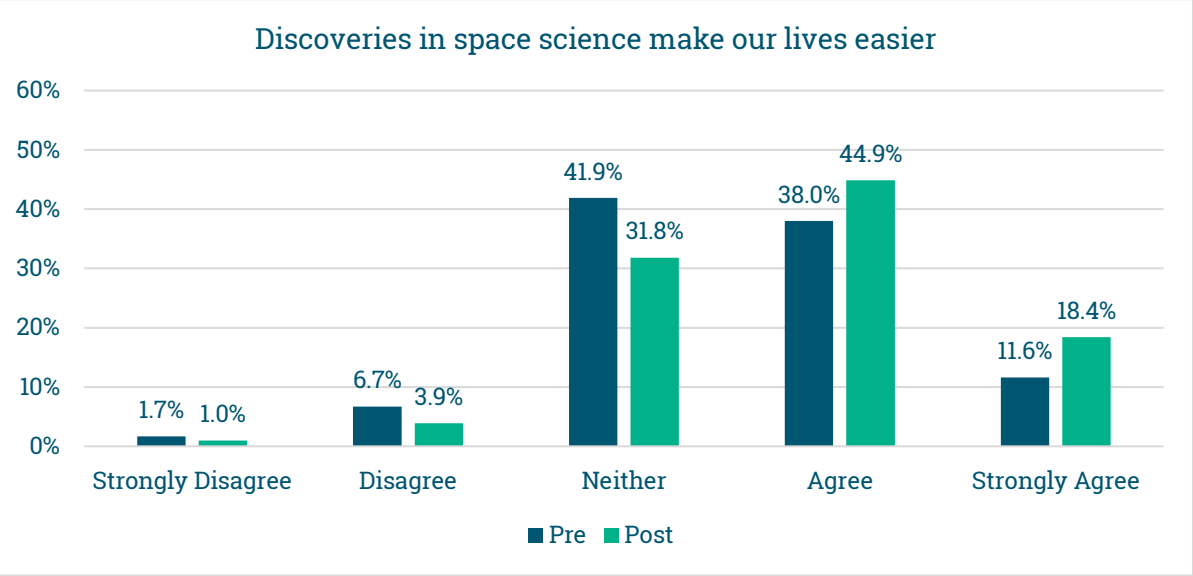

I would like to find out more about jobs in the space science industry
60%
50%
40%
30%
20%
10%
0%
3.7%
1.8%
13.5%
11.4%
26.1%
28.2%
41.8%
45.1%
14.9%
13.6%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post

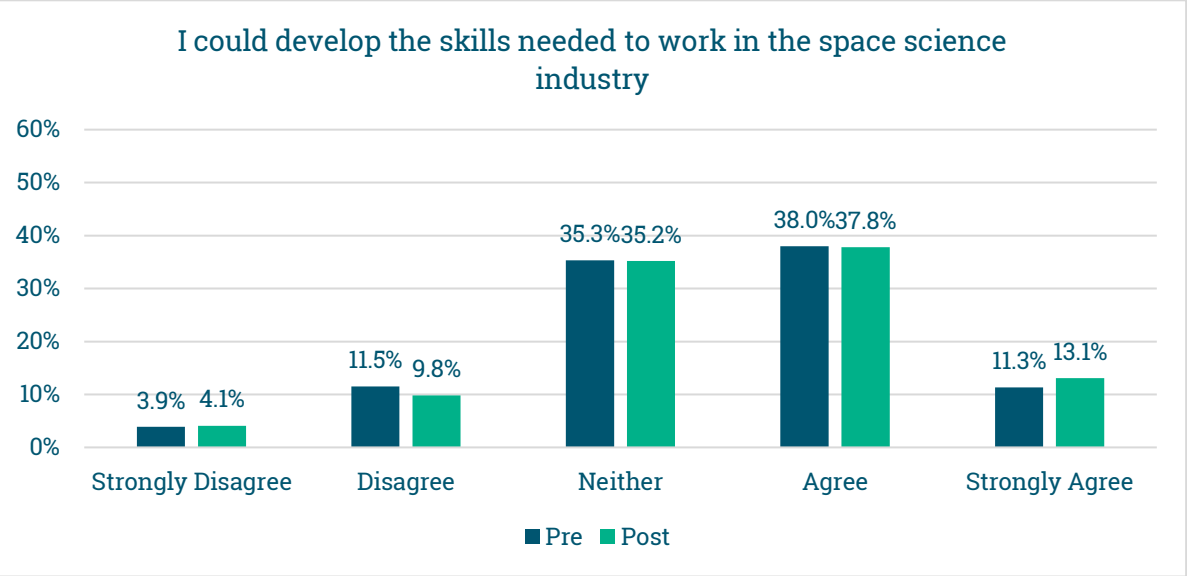

I would like to work in the space science industry
60%
50%
40%
30%
20%
10%
0%
14.0%
12.4%
25.7%
24.3%
39.0%
42.2%
14.7%
14.8%
6.6%
6.3%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post

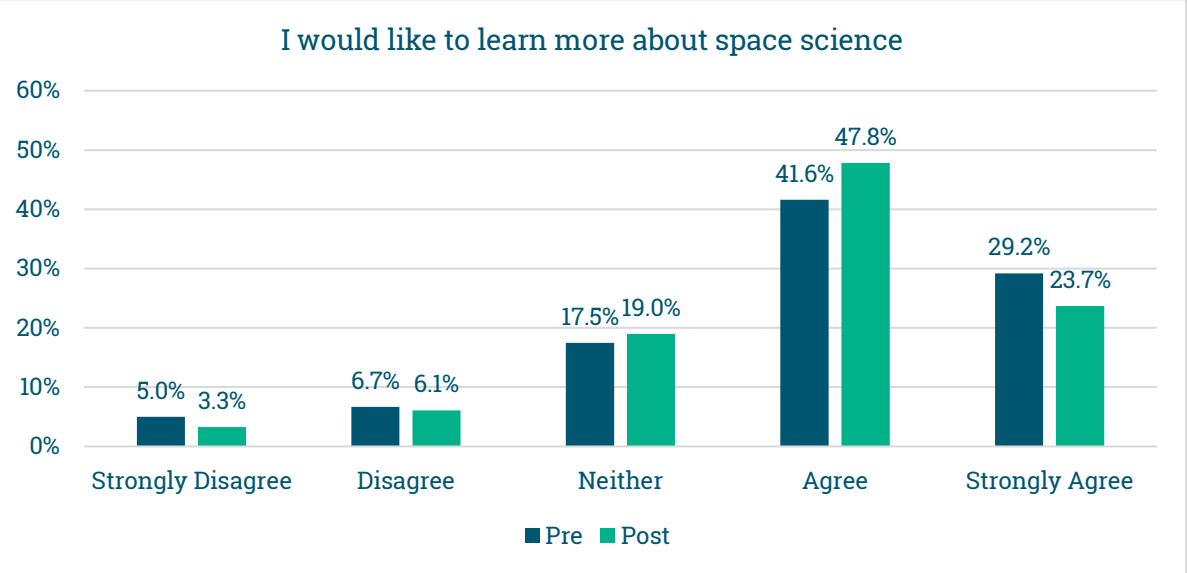

I am clever enough to work in the space science industry
60%
50%
40%
30%
20%
10%
0%
13.0%
8.8%
17.2%
16.9%
42.8%
43.1%
19.3%
21.0%
7.7%
10.2%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post


Discoveries in space science help the environment
60%
50%
40%
30%
20%
10%
0%
1.4%
1.7%
3.9%
3.5%
27.5%
23.3%
44.2%
47.1%
22.9%
24.3%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post


I would like to have a job related to space science
60%
50%
40%
30%
20%
10%
0%
10.5%
9.5%
24.4%
20.9%
39.8%
42.5%
17.9%
18.7%
7.4%
8.5%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post


Discoveries in space science make our lives easier
60%
50%
40%
30%
20%
10%
0%
1.7%
1.0%
6.7%
3.9%
41.9%
31.8%
38.0%
44.9%
11.6%
18.4%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post


I could develop the skills needed to work in the space science industry
60%
50%
40%
30%
20%
10%
0%
3.9%
4.1%
11.5%
9.8%
35.3%
35.2%
38.0%
37.8%
11.3%
13.1%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post


I would like to learn more about space science
60%
50%
40%
30%
20%
10%
0%
5.0%
3.3%
6.7%
6.1%
17.5%
19.0%
41.6%
47.8%
29.2%
23.7%
Strongly Disagree
Disagree
Neither
Agree
Strongly Agree
Pre
Post

Appendix 2 – Students' Responses to Survey Statements in Denmark

Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change
Space science is interesting	57.8%	-	-
Discoveries in space science are important to society*	68.7%	70.3%	+1.6%
People from different countries work in space science	39.9%	-	-
I could work in the space science industry when I grow up if I wanted to*	39.9%	40.2%	+0.3%
All kinds of different people work in the space science industry*	59.4%	71.3%	+11.9%
I enjoy learning about space science*	57.7%	65.7%	+8.0%
I would like to find out more about jobs in the space science industry	43.5%	-	-
I would like to work in the space science industry*	11.3%	7.4%	-3.9%
I am clever enough to work in the space science industry	47.6%	-	-
Discoveries in the space science help the environment	42.9%	-	-
I would like to have a job related to space science	14.3%	-	-
Discoveries in space science make our lives easier	30.6%	-	-
I could develop the skills needed to work in the space science industry	27.9%	-	-
I would like to learn more about space science	69.8%	-	-

Appendix 3 – Students' Responses to Survey Statements in England

Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change
I enjoy learning about space science*	52.7%	71.8%	+19.1%
Space science is interesting	60.9%	79.6%	+18.7%
People from different countries work in space science	77.9%	89.6%	+11.7%
I would like to have a job related to space science	17.3%	28.2%	+10.9%
I would like to work in the space science industry*	17.0%	27.3%	+10.3%
All kinds of different people work in the space science industry*	80.1%	90.4%	+10.3%
I would like to learn more about space science	54.4%	63.3%	+8.9%
Discoveries in space science are important to society*	64.7%	72.9%	+8.2%
Discoveries in space science make our lives easier	39.1%	46.3%	+7.2%
I would like to find out more about jobs in the space science industry	36.8%	42.4%	+5.6%
I could work in the space science industry when I grow up if I wanted to*	38.9%	44.4%	+5.5%
I am clever enough to work in the space science industry	25.7%	31.0%	+5.3%
Discoveries in the space science help the environment	58.6%	61.9%	+3.3%
I could develop the skills needed to work in the space science industry	47.4%	48.6%	+1.2%

Appendix 4 – Students' Responses to Survey Statements in Italy

Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change
Discoveries in space science make our lives easier	50.8%	62.0%	+11.2%
Discoveries in the space science help the environment	71.1%	81.0%	+9.9%
I am clever enough to work in the space science industry	27.2%	35.7%	+8.5%
I could develop the skills needed to work in the space science industry	53.9%	60.1%	+6.2%
All kinds of different people work in the space science industry*	21.5%	27.0%	+5.5%
People from different countries work in space science	86.2%	91.5%	+5.3%
Discoveries in space science are important to society*	88.2%	92.3%	+4.1%
I enjoy learning about space science*	69.6%	72.9%	+3.3%
Space science is interesting	91.1%	93.9%	+2.8%
I would like to find out more about jobs in the space science industry	69.9%	72.3%	+2.4%
I would like to learn more about space science	84.5%	86.5%	+2.0%
I would like to have a job related to space science	35.3%	35.1%	-0.2%
I could work in the space science industry when I grow up if I wanted to*	40.1%	37.1%	-3.0%
I would like to work in the space science industry*	36.2%	31.5%	-4.7%

Appendix 5 – Students' Responses to Survey Statements in Portugal

Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change
All kinds of different people work in the space science industry*	50.6%	62.1%	+11.5%
Discoveries in space science make our lives easier	68.0%	76.8%	+8.8%
People from different countries work in space science	73.0%	81.3%	+8.3%
Space science is interesting	87.8%	90.2%	+2.4%
I could develop the skills needed to work in the space science industry	49.9%	51.4%	+1.5%
I am clever enough to work in the space science industry	30.1%	31.4%	+1.3%
I enjoy learning about space science*	82.8%	84.0%	+1.2%
Discoveries in space science are important to society*	90.7%	90.4%	-0.3%
I would like to work in the space science industry*	25.0%	23.2%	-1.8%
I could work in the space science industry when I grow up if I wanted to*	28.7%	26.2%	-2.5%
I would like to learn more about space science	78.5%	75.7%	-2.8%
I would like to find out more about jobs in the space science industry	71.6%	67.9%	-3.7%
I would like to have a job related to space science	31.8%	27.7%	-4.1%
Discoveries in the space science help the environment	76.0%	70.5%	-5.5%

Appendix 6 – Students' Responses to Survey Statements in Wales

Statement	Percentage of Participants who Agreed/Strongly Agreed		
	Pre	Post	Change
Discoveries in the space science help the environment	63.5%	79.1%	+15.6%
Discoveries in space science make our lives easier	37.9%	51.6%	+13.7%
Space science is interesting	66.0%	76.2%	+10.2%
People from different countries work in space science	76.9%	85.6%	+8.7%
I am clever enough to work in the space science industry	22.2%	27.7%	+5.5%
All kinds of different people work in the space science industry*	83.2%	86.4%	+3.2%
I would like to have a job related to space science	16.2%	18.0%	+1.8%
I enjoy learning about space science*	64.8%	65.6%	+0.8%
Discoveries in space science are important to society*	75.3%	75.3%	0.0%
I would like to work in the space science industry*	18.5%	18.4%	-0.1%
I could work in the space science industry when I grow up if I wanted to*	43.9%	43.7%	-0.2%
I would like to find out more about jobs in the space science industry	45.1%	44.7%	-0.4%
I could develop the skills needed to work in the space science industry	48.5%	45.7%	-2.8%
I would like to learn more about space science	64.7%	60.5%	-4.2%

OUR SPACE
OUR FUTURE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement N° 821871

For more information:
www.ourspaceourfuture.eu

OURSPACE_FUTURE

Ourspaceourfuture

OURSPACE_FUTURE

OURSPACE_FUTURE