Pupil Survey
~ Technical Annex ~

This technical annex contains thorough descriptions of the pupil survey data, including the sample and, particularly, details of the analyses. It should be read in conjunction with the main summary report on this work.

Contents

This project is funded the European Commission's Horizon 2020 Programme under grant agreement n° 638653.

1. Participating students

This pupil survey was devised as part of the Space Awareness project, and aimed to explore at international level students' attitudes towards and experiences of space science. It was distributed internationally by the Space Awareness network of partners and nodes (see Appendix for a copy of the survey, as well as the instructions to the nodes regarding data collection). 9202 students from 17 countries logged onto the survey and answered at least one content question. Of the sample of 9202, 8837 responded to the second to last question – an acceptable dropout rate of 9.6%. [N.B. there were fewer responses to the final question because Greek students' responses were excluded for technological reasons.]

Missing data was handled by excluding students from analysis unless they had answered sufficient questions to be included in the relevant analyses. (That is, analyses which focus on items earlier in the survey will be based on a greater number of students than those relying on later items.) This is a more conservative approach than trying to impute missing data. It is also appropriate because data was not missing at random (a question skipped here or there) but because later questions were less likely to be answered than earlier.

The number of students participating from each of the 17 countries is displayed below (Table 1.1 and Figure 1.1[1]). For country-level analysis, the UK and Ireland were combined (to achieve a sufficiently large sample for analysis) and non-European countries were excluded, as were countries with insufficient numbers of students (Belgium, Norway, Netherlands).

Country	Frequency	Percent
Belgium (Dutch-speaking)	135	1.5
Bulgaria	700	7.6
Czech Republic	710	7.7
France	1209	13.1
French (Other)[2]	73	0.8
Germany	689	7.5
Greece	661	7.2
Ireland	288	3.1
Italy	553	6.0
Netherlands	125	1.4
Nigeria	299	3.2
Norway	240	2.6
Poland	904	9.8
Portugal	688	7.5
Romania	733	8.0
Spain	517	5.6
UK	631	6.9
Other	47	0.5
Total	***9202***	***100.0***

Table 1.1 – Participating students, by country

[1] We recognise that these data may be subject to secondary analysis therefore have included both tables and figures to assist with that process.

[2] 'French (other)' refers to students who completed the French survey but were not in France (for example from India or Djibouti).

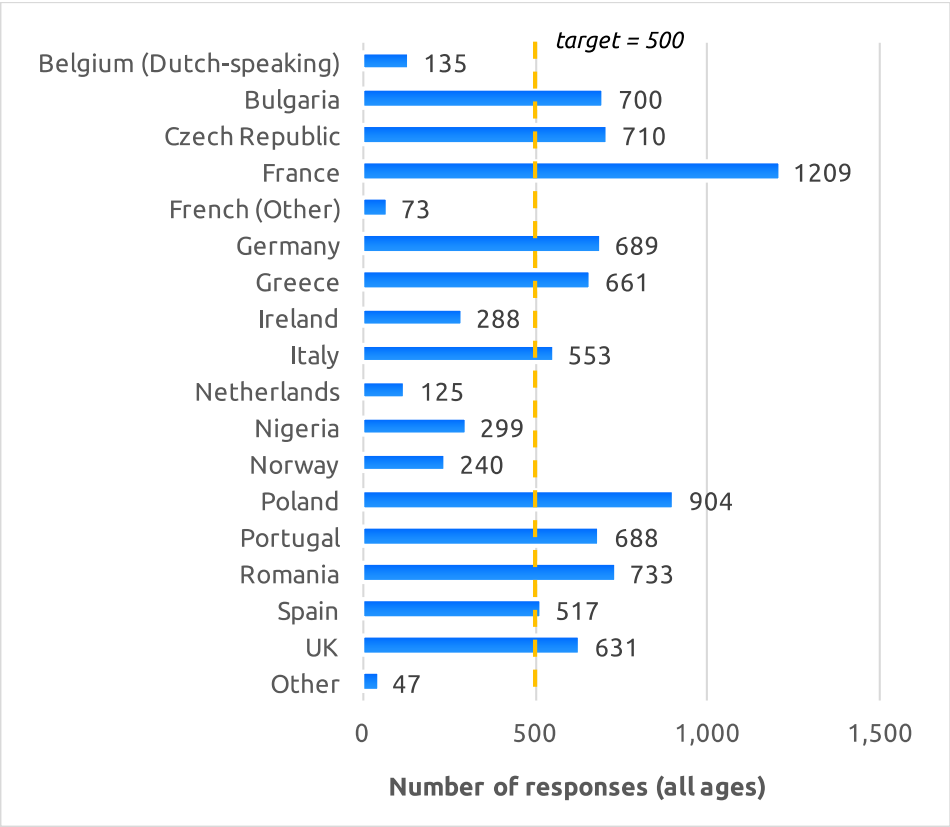

Figure 1.1 - Participating students, by country

1.1 Age and gender distributions

Overall, the survey had a target age range of 11-14, which corresponds to late primary/early secondary school in most European countries. This range was chosen as it is at these ages during which aspirations continue to form and solidify, when young people continue to develop images of who does/does not (or can/cannot) work in science (see for example Archer & DeWitt, 2017). Additionally, in most countries, these ages are also when students begin to have to make decisions about their educational paths (e.g. around how much science to take within their educational studies).

Because student age does not align neatly with year group (i.e. all students in a particular school year group are not a single age throughout the year), the age range was expanded to include ages 10-15 (in order to ensure we captured the key range of 11-14). In terms of the sample size, we had to consider the balance between the need for statistical power (the capacity to detect differences among groups) and the capacity of the nodes to recruit students. Consequently, we decided to aim for 500 students from each country, at the following ages:

- Age 10: 50
- Age 11: 100
- Age 12: 100
- Age 13: 100
- Age 14: 100
- Age 15: 50

In the actual implementation of the survey, due to the way in which schools were approached and recruited and because any given year group has a span of ages, the age range was actually 9-16 (Table 1.2). Because the target age range was 10-15, ages 9 and 10 were combined for analysis, as were ages 15 and 16 (Figure 1.2).

Age	Frequency	Percent
9	340	3.7
10	673	7.3
11	1343	14.6
12	1564	17.0
13	1545	16.8
14	1450	15.8
15	1184	12.9
16	1103	12.0
Total	***9202***	***100.0***

Table 1.2 – Participating students, by age

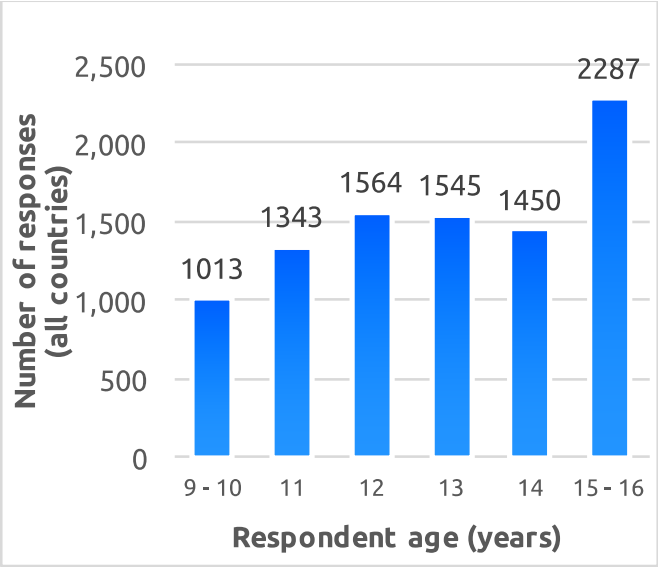

Figure 1.2 - Participating students, by age

Compared to the original targets our data are clearly weighted towards the older age ranges. Consequently, the data were weighted by age for analysis, to better correspond to the target proportions.

Of the participating students, 4739 (51.5%) were female and 4397 (47.8%) were male (66 students did not respond to this question, Figure 1.3). These proportions were deemed to be sufficiently close to 50/50 that weighting by gender in the subsequent analyses was unnecessary.

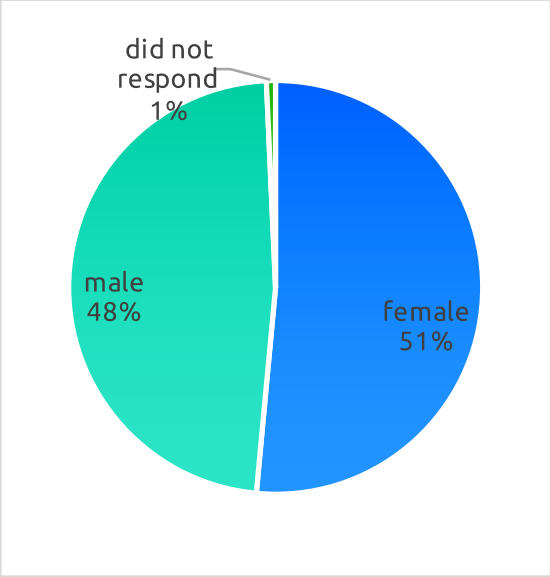

Figure 1.3 - Gender distribution

2. Initial analyses

2.1 Item frequencies

In order to gain an overall feel for the data and how participants responded, the first step in analysis was to calculate the percentage agreement/disagreement with each survey item. To align with later analyses these items are presented on subsequent pages broadly grouped into the following themes (categories)[3]:

- Interest in space-related activities
- Space science and my future
- Positive attitudes to space science
- Perceptions of work in space science
- Preparing for work in space science
- Valuing space science
- Additional items (not included in the above themes / categories)

[3] These themes (categories) were determined statistically using factor analyses, as described in section 2.2.

2.1.1 Interest in space-related activities

How much would you like to do the following things in your spare time?					
	Look through a telescope or go star gazing	**Read about space in books or magazines**	**Find out about space online**	**Watch a TV programme about space**	**Talk with someone else about space**
Very much	3663 (40.9)	1465 (16.4)	1941 (21.8)	2862 (32.1)	2307 (25.9)
Some	2432 (27.2)	2254 (25.2)	2306 (25.9)	2549 (28.6)	2069 (23.2)
A little	1330 (14.9)	2101 (23.5)	2077 (23.3)	1623 (18.2)	1746 (19.6)
Not much	822 (9.2)	1698 (19.0)	1496 (16.8)	1045 (11.7)	1419 (15.9)
Not at all	709 (7.9)	1410 (15.8)	1079 (12.1)	833 (9.3)	1362 (15.3)
Total	***8956 (100.0)***	***8928 (100.0)***	***8899 (100.0)***	***8912 (100.0)***	***8903 (100.0)***

Table 2.1 - Participant responses to questions relating to interest in space-related activities *(percentages for each question indicated in brackets)*

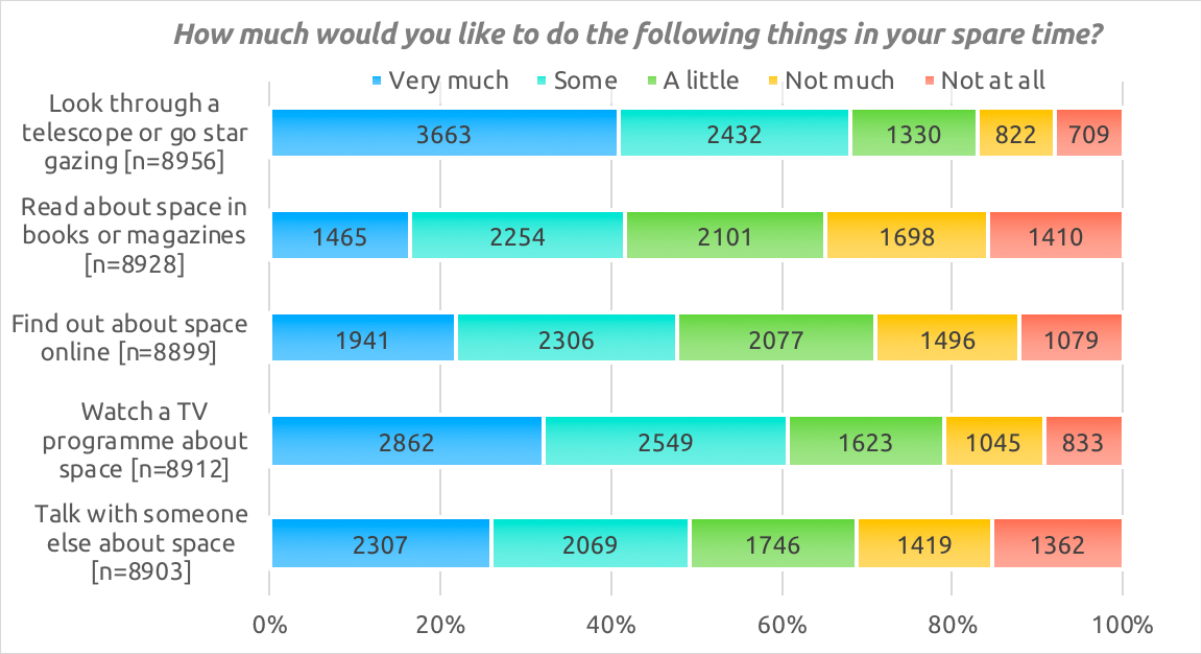

Figure 2.1 - Participant responses to questions relating to interest in space-related activities

The responses to the items in this category suggest quite substantial interest in space-related activities. In particular, over half of respondents indicated they would be interested (responding 'very much' or 'some') in watching a TV programme about space (60.7%) or looking through a telescope/going star gazing (68.1%), while fewer were interested in reading about space in books or magazines (41.6%).

2.1.2 Space science and my future

	I would like to study space science in the future	I want to find out more about jobs related to space	People who are like me work in jobs related to space	I would like to have a job related to space
Strongly agree	1300 (14.2)	1983 (21.8)	964 (10.7)	1284 (14.6)
Agree	2019 (22.0)	3097 (34.1)	1806 (20.0)	1492 (16.9)
Neither agree nor disagree	2904 (31.6)	2185 (24.1)	3509 (38.8)	2768 (31.4)
Disagree	1640 (17.9)	1202 (13.2)	1493 (16.5)	1766 (20.0)
Strongly disagree	1316 (14.3)	615 (6.8)	1273 (14.1)	1506 (17.1)
Total	***9179 (100.0)***	***9082 (100.0)***	***9045 (100.0)***	***8816 (100.0)***

Table 2.2 - Participant responses to questions relating to space science and my future

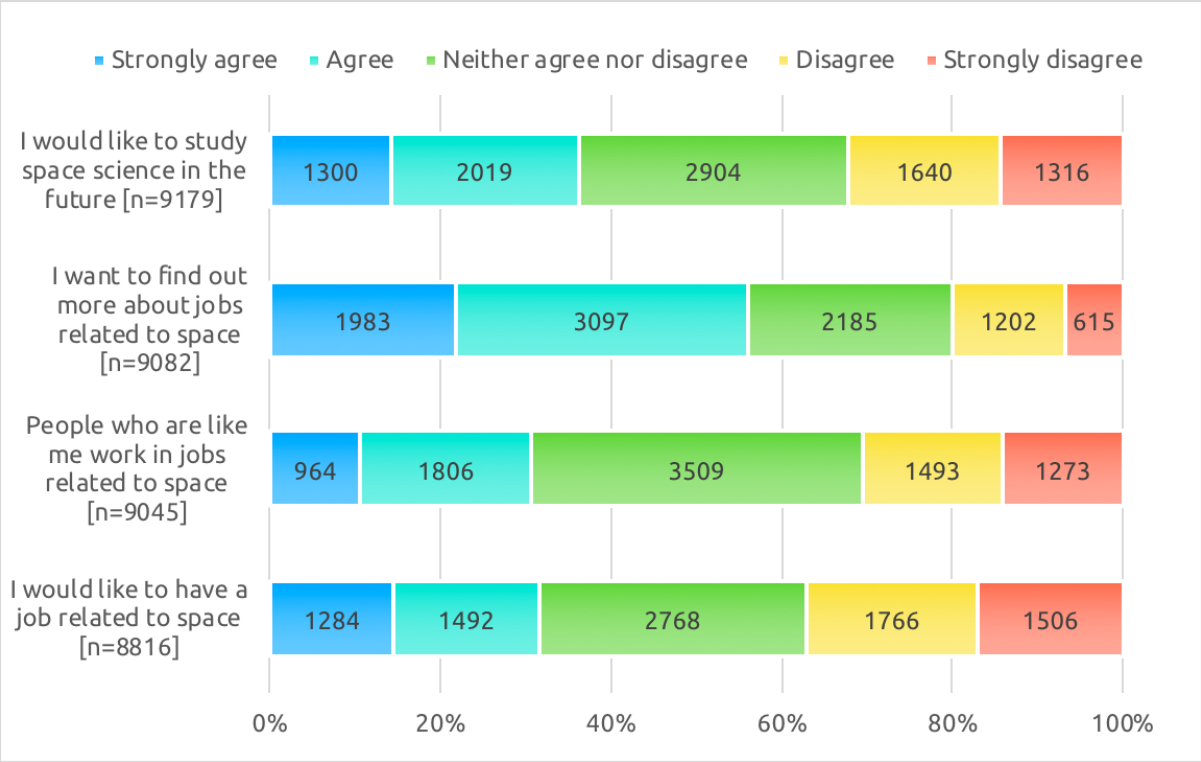

Figure 2.2 - Participant responses to questions relating to space science and my future

Although a substantial proportion of respondents were interested in engaging in space-related activities in their spare time, noticeably fewer could envision space science in their own future, particularly in terms of careers. Although over half (55.9%) agreed or strongly agreed that they would like to find out more about careers related to space, only around 1/3 felt people like them worked in jobs related to space (30.7%) or wanted to have a job related to space (31.5%). That said, that proportion does contrast positively with the proportions of pupils interested in 'becoming a scientist' in the ASPIRES studies (Archer & DeWitt, 2017), which tended to hover around 18%.

2.1.3 Positive attitudes to space science

	Jobs in space science are boring	I enjoy learning about space	I would like to find out more about space	Space science is interesting
Strongly agree	571 (6.3)	3006 (33.9)	3185 (36.1)	3460 (39.2)
Agree	706 (7.7)	3280 (37.0)	3264 (37.0)	3058 (34.6)
Neither agree nor disagree	1903 (20.9)	1543 (17.4)	1388 (15.7)	1449 (16.4)
Disagree	3135 (34.4)	551 (6.2)	609 (6.9)	465 (5.3)
Strongly disagree	2796 (30.7)	489 (5.5)	384 (4.3)	399 (4.5)
Total	***9111 (100.0)***	***8869 (100.0)***	***8830 (100.0)***	***8831 (100)***

Table 2.3 - Participant responses to questions relating to positive attitudes to space science

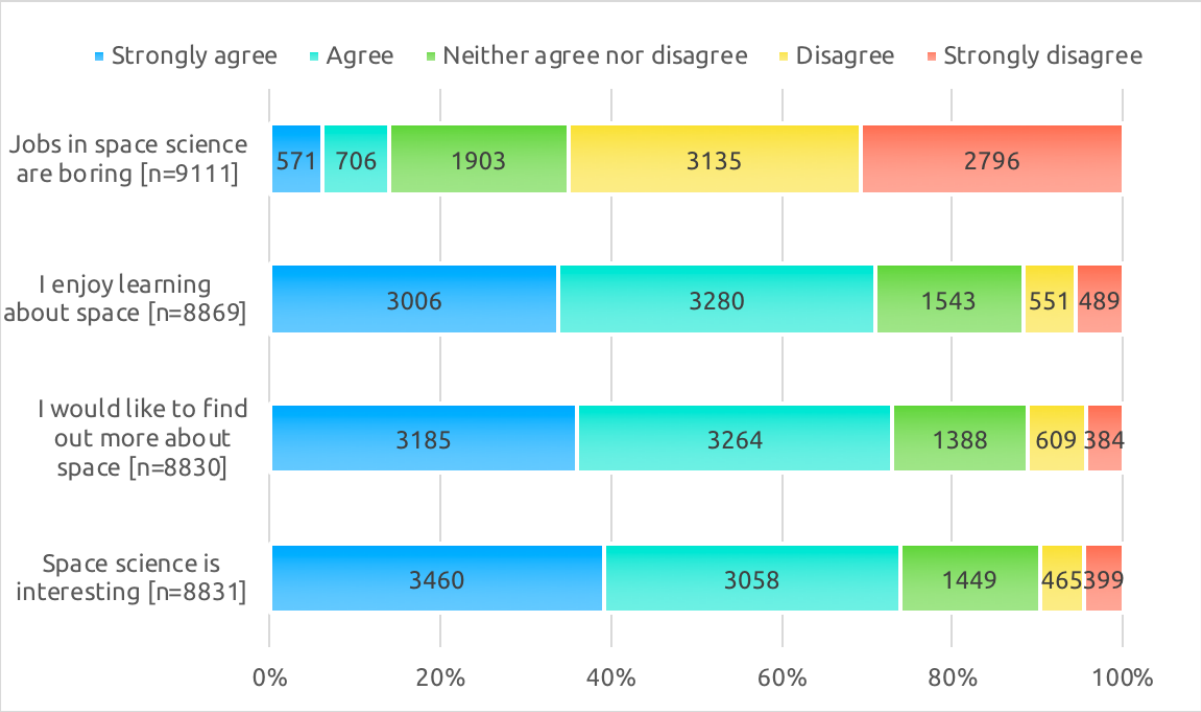

Figure 2.3 - Participant responses to questions relating to positive attitudes to space science

Although only about 1/3 of respondents expressed an interest in having a job related to space science (section 2.1.2), Table 2.3 and Figure 2.3 suggest that this does not seem to be due to negative perceptions of space science. Indeed, attitudes to space science would seem to be incredibly positive, with close to three-quarters of respondents agreeing/strongly agreeing that they enjoy learning about space science (70.9%), would like to find out more about space (73.1%) and that space science is interesting (73.8%). Correspondingly, only 14.0% agreed that jobs in space science are boring.

2.1.4 Perceptions of work in space science

	Space scientists or people who work in jobs related to space come from many different cultures	There are many kinds of jobs in space science	Important discoveries about space have been made by women	Important discoveries about space have been made by people from many different cultures
Strongly agree	3447 (37.9)	2204 (24.3)	1259 (14.1)	3281 (36.8)
Agree	3638 (40.0)	4296 (47.3)	1672 (18.8)	3549 (39.8)
Neither agree nor disagree	1447 (15.9)	1952 (21.5)	3983 (44.8)	1603 (18.0)
Disagree	355 (3.9)	451 (5.0)	1302 (14.6)	317 (3.6)
Strongly disagree	211 (2.3)	175 (1.9)	684 (7.7)	158 (1.8)
Total	***9098 (100.0)***	***9078 (100.0)***	***8900 (100.0)***	***8908 (100.0)***

	People with many different jobs work together to make discoveries about space	People from many different countries work together to make discoveries about space	It is important that people from many different cultures work in space science	It is important that both women and men work in jobs related to space science
Strongly agree	2643 (29.7)	4194 (47.1)	3383 (38.0)	4555 (51.1)
Agree	3244 (36.4)	3049 (34.2)	2908 (32.6)	2471 (27.7)
Neither agree nor disagree	2077 (23.3)	1223 (13.7)	1860 (20.9)	1200 (13.5)
Disagree	646 (7.3)	256 (2.9)	391 (4.4)	348 (3.9)
Strongly disagree	318 (3.6)	197 (2.2)	278 (3.1)	280 (3.1)
Total	***8928 (100.0)***	***8919 (100.0)***	***8820 (100.0)***	***8854 (100.0)***

Table 2.4 - Participant responses to questions relating to perceptions of work in space science

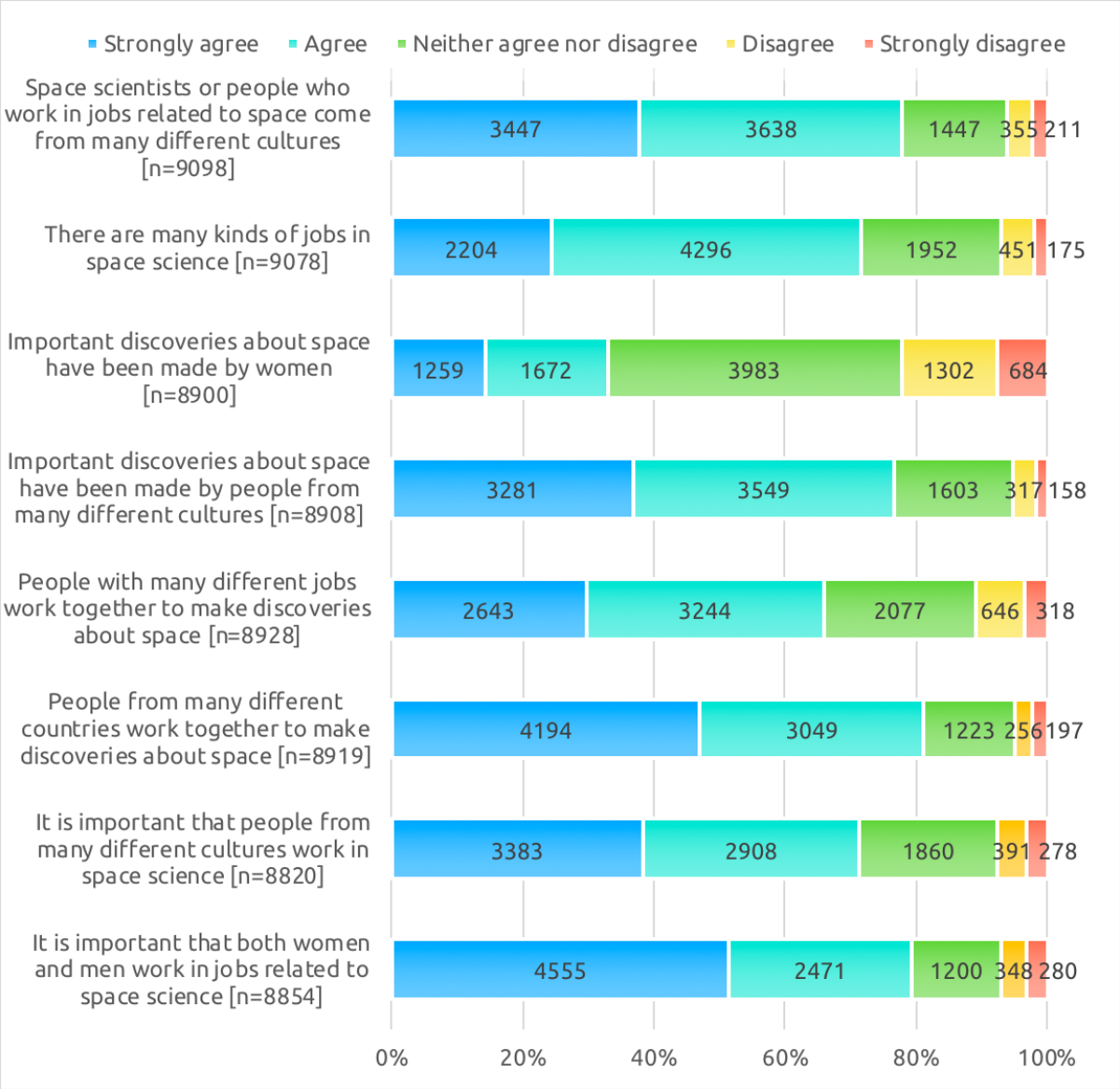

Figure 2.4 - Participant responses to questions relating to perceptions of work in space science

Responses to statements in this category suggest that students' perceptions of work in space science are fairly open-minded, with a clear emphasis on valuing contributions across cultures, backgrounds, skill sets and genders. Agreement with statements in this category ranged from 65.9% (People with many different jobs work together to make discoveries about space) to 81.2% (People from many different countries work together to make discoveries about space). There was however one notable exception, namely, 'Important discoveries about space have been made by women'. Only 32.9% of respondents agreed with that item, although nearly half neither agreed nor disagreed, suggesting uncertainty around the item (or an inability to think of notable female space scientists). Moreover, this may also be a reflection of awareness of a historically inequitable situation, rather than an opinion that women are not capable of making such discoveries or working in the field, given that 79.4% agreed it was important that both men and women work in jobs related to space science.

2.1.5 Preparing for work in space science

	Space scientists or people who work in jobs related to space always have university degrees	Space scientists or people who work in jobs related to space had to study for many years to get their job	You have to study science to get a job related to space
Strongly agree	3480 (38.5)	4115 (45.2)	2731 (30.1)
Agree	3231 (35.7)	3207 (35.2)	3659 (40.3)
Neither agree nor disagree	1721 (19.0)	1334 (14.7)	1891 (20.8)
Disagree	423 (4.7)	271 (3.0)	561 (6.2)
Strongly disagree	194 (2.1)	178 (2.0)	229 (2.5)
Total	***9049 (100.0)***	***9105 (100.0)***	***9071 (100.0)***

Table 2.5 - Participant responses to questions relating to preparing for work in space science

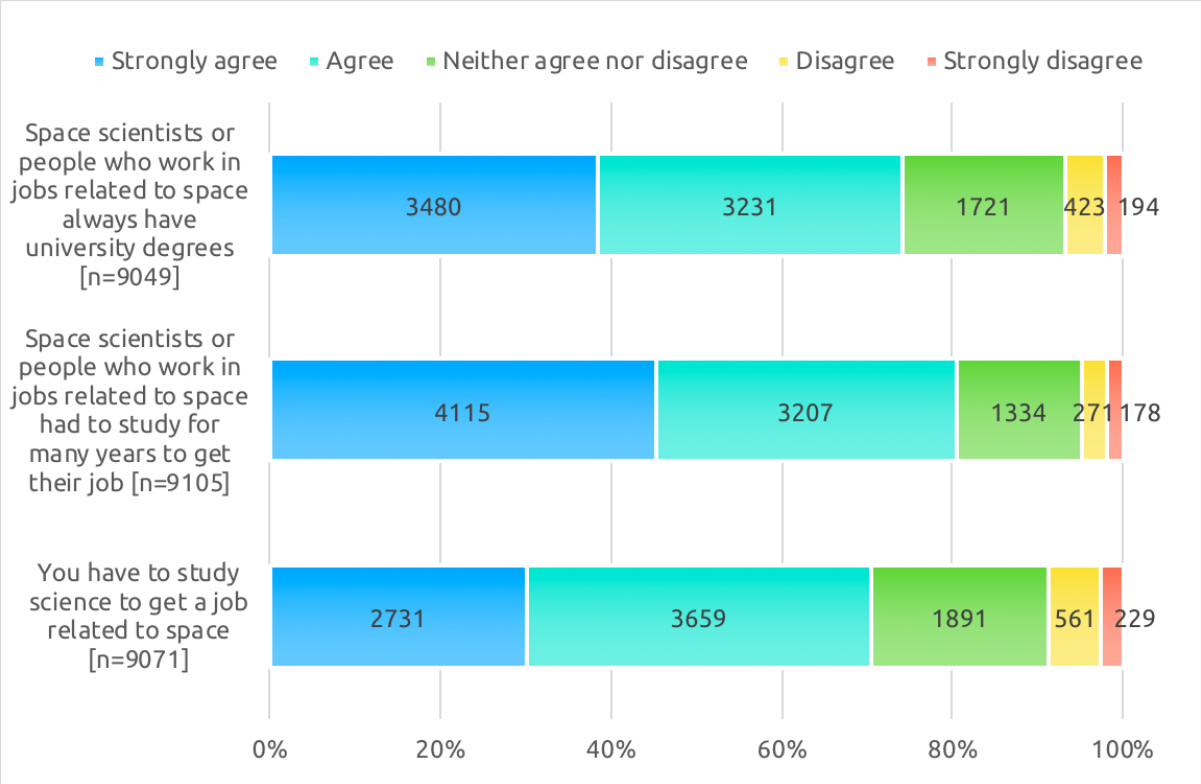

Figure 2.5 - Participant responses to questions relating to preparing for work in space science

Responses to the statements in this category suggest a perception of work in space science as something that is (not surprisingly), strongly related to science, as well as work that requires a long period of intense preparation. In particular, 74.2% agreed that people who work in space science always have university degrees, while 80.4% agreed that they had to study for many years to get their job.

2.1.6 Valuing space science

	It is important to learn about space	Understanding about space is important for society	Discoveries in space science can help society in general	Discoveries in space science can make MY daily life better
Strongly agree	3041 (33.2)	2684 (29.4)	3544 (39.5)	1711 (19.2)
Agree	3756 (41.1)	3477 (38.0)	3601 (40.2)	2780 (31.1)
Neither agree nor disagree	1653 (18.1)	2002 (21.9)	1339 (14.9)	2806 (31.4)
Disagree	461 (5.0)	658 (7.2)	320 (3.6)	1144 (12.8)
Strongly disagree	235 (2.6)	321 (3.5)	163 (1.8)	487 (5.5)
Total	***9146 (100.0)***	***9142 (100.0)***	***8967 (100.0)***	***8928 (100.0)***

Table 2.6 - Participant responses to questions relating to valuing space science

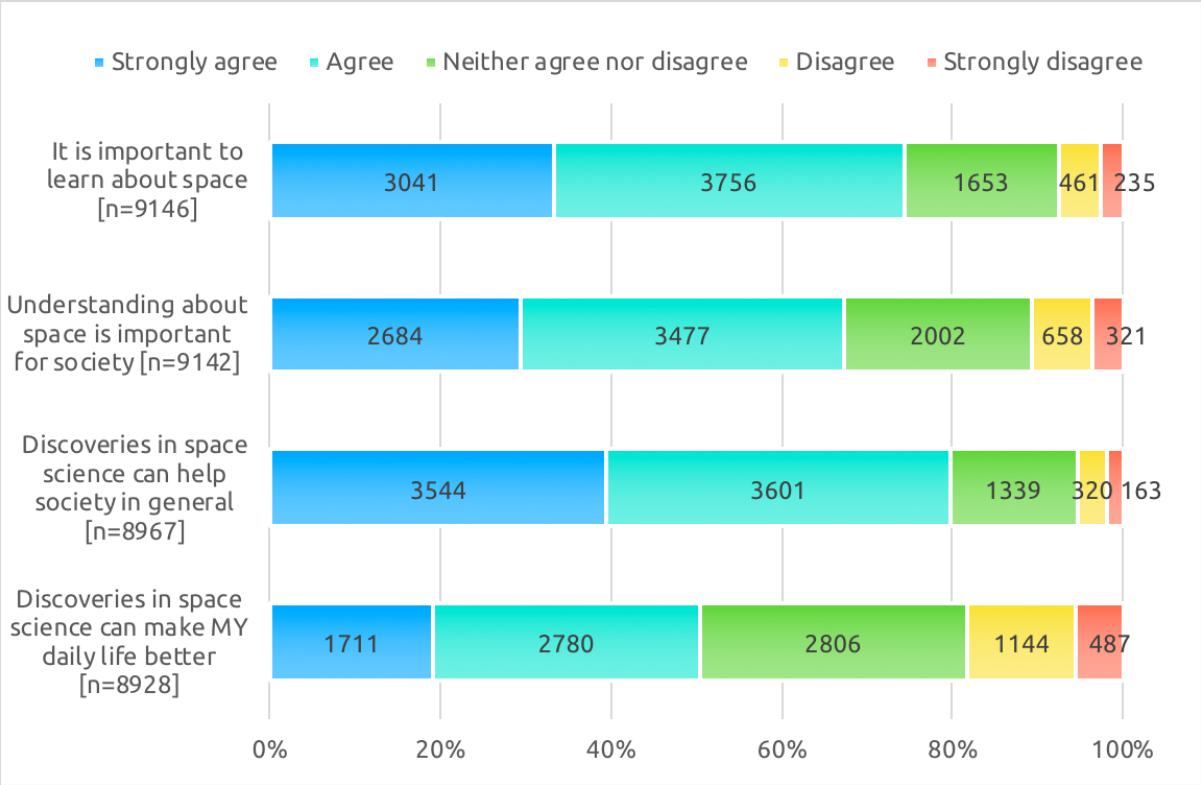

Figure 2.6 - Participant responses to questions relating to valuing space science

In addition to holding positive attitudes about space science, students also tended to value space science and its contribution to society. For instance, over 2/3 felt that it is important to learn about space and that understanding about space is important to society. Furthermore, nearly 80% agreed that discoveries in space science can help society in general. However, (and resonating with many findings about young people feeling science generally is 'important, but not for me'), far fewer (about 50%) agreed that discoveries in space science can make their own daily lives better.

2.1.7 Additional items (not included in above themes/categories)

	Studies in space science can help people get many different types of jobs	Space scientists or people who work in jobs related to space have many other interests	Space scientists or people who work in jobs related to space are usually men	Jobs in space science use skills we learn in science lessons in school	I have family and/or friends who are interested in space
Strongly agree	1920 (21.0)	1948 (21.4)	1000 (11.1)	1873 (20.6)	1615 (17.8)
Agree	3864 (42.2)	3721 (40.8)	2080 (23.0)	3416 (37.6)	2093 (23.0)
Neither agree nor disagree	2282 (24.9)	2543 (27.9)	2491 (27.6)	2353 (25.9)	2325 (25.6)
Disagree	772 (8.4)	659 (7.2)	2136 (23.6)	935 (10.3)	1379 (15.2)
Strongly disagree	314 (3.4)	251 (2.8)	1332 (14.7)	505 (5.6)	1425 (15.7)
Total	***9152 (100.0)***	***9122 (100.0)***	***9039 (100.0)***	***9082 (100.0)***	***8837 (100.0)***

Table 2.7 - Participant responses relating to all remaining indicator statements

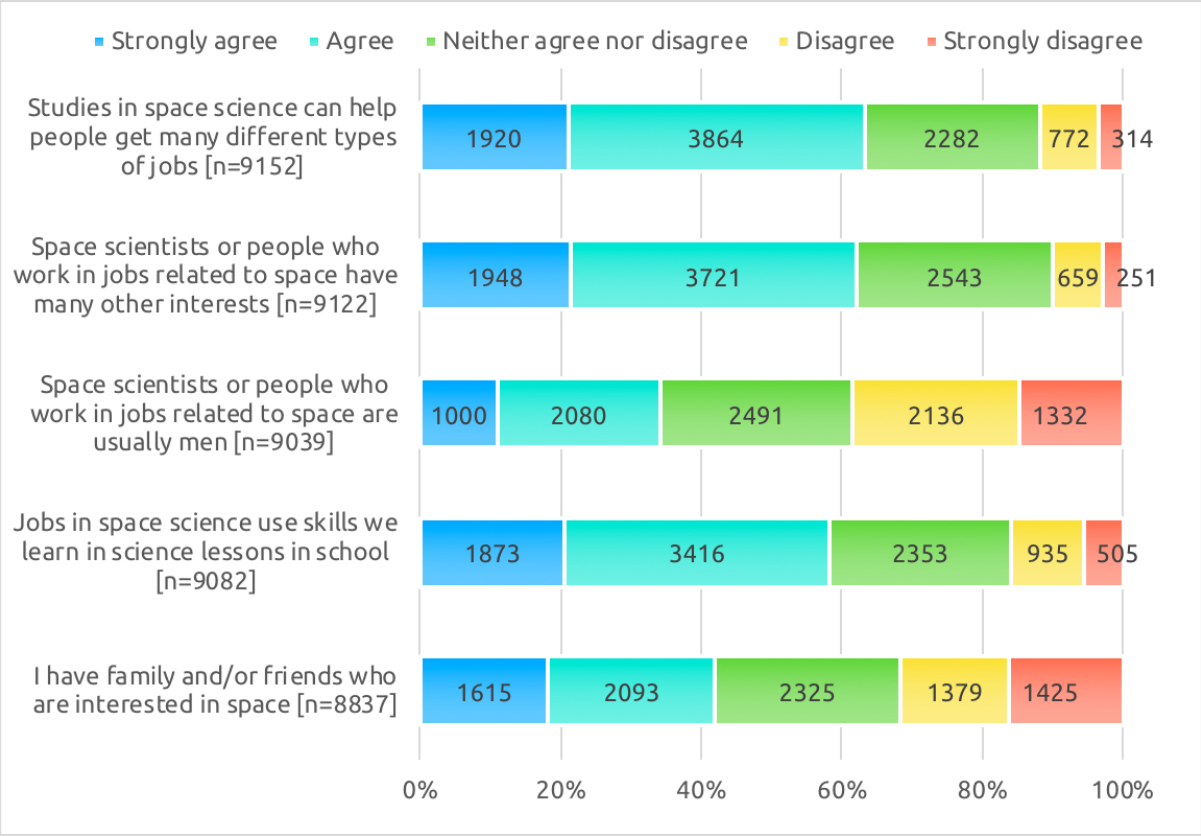

Figure 2.7 - Participant responses relating to all remaining indicator statements

Figure 2.7 and Table 2.7 contain statements that were insufficiently related statistically to other statements to be included in any of the previous categories. However, they are in broad agreement with those trends, in that they suggest generally positive perceptions of space science, with over half agreeing that studies in space science can be helpful in getting a range of jobs, and that individuals working in space science have other interests. There is also some indication of a link between their own lived experience and space science, with over half agreeing that jobs in space science use skills they learn in school. However, there seems to be less interest in space among friends and family, with only 42% agreeing that they have friends or family interested in space. Finally, about 1/3 of respondents felt that space scientists were usually men, although another 28% were unsure, perhaps suggesting a tension between an ideal situation (in which both men and women work in space science) and what the likely reality (of a male-dominated field).

How often do you learn about topics related to space in lessons at school?	Frequency	Percent
More than once a month	1571	19.3
About once a month	1404	17.2
Once a term	2214	27.2
Once a year	1868	22.9
Never	1095	13.4
Total	***8152***	***100.0***

Table 2.8 – Participant responses to how often they cover space science in school lessons *[N.B., this table does not include Greek responses due to technology issues]*

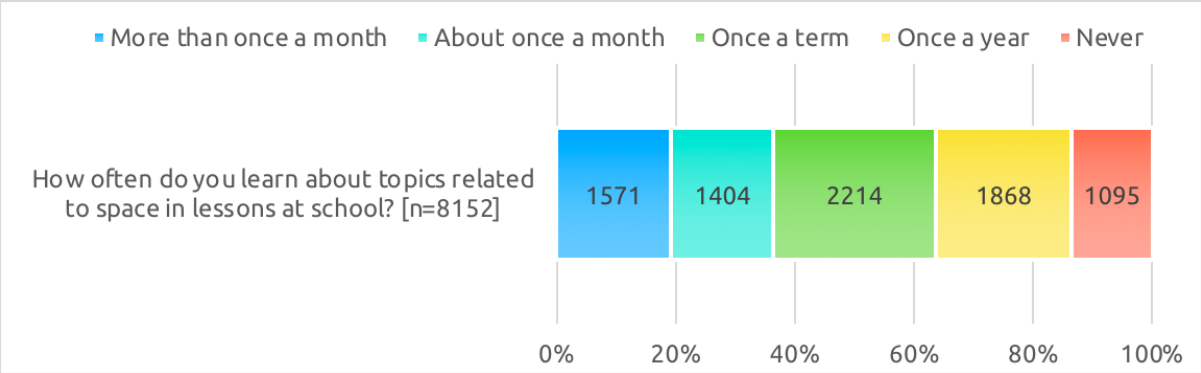

Figure 2.8 – Participant responses to how often they cover space science in school lessons *[N.B., this table does not include Greek responses due to technology issues]*

Finally, Table 2.8 and Figure 2.8 suggest that space science is covered in many students' lessons. That said, caution is urged in interpreting these findings, as the Space Awareness review of the curriculum of many European countries suggested that space science was insufficiently prominent in any of those curricula to be covered more than once a month (or even once a month). Despite concerns about accuracy, however, it would seem that students perceive it to be covered at least to some extent.

2.2 Psychometric validity

In order to check the reliability and validity of the survey instrument, exploratory factor analysis and Cronbach's alpha measures were used. More specifically, exploratory factor analyses (EFA) are used to see whether the items group together into interpretable or understandable scales, or 'factors'. Put simply, each factor contains a number of items which are related to each other and so tap into some sort of underlying construct. In addition, after EFA has been performed and it has been decided which items will be grouped together into factors (or scales), Cronbach's alpha, a measure of internal consistency, is used to measure the reliability of the scale. That is, it gives a sense of whether the items, indeed, all measure a single underlying construct.

The value of grouping items in this way (into categories, or scales) is that the factors can be used to create variables which can, in turn, be used in additional analyses. That is, by grouping items together, more robust data is created which can give a better overview of the way people have responded, rather than simply looking at each item individually. For instance, individuals can have a mean score on a variable which can then be compared between groups (e.g. males and females).

Exploratory factor analysis revealed the following six factors:

- Interest in space-related activities
- Space science and my future
- Positive attitudes to space science
- Perceptions of work in space science
- Preparing for work in space science
- Valuing space science

It is these groupings that were used in further analyses. In addition, other measures related to the sample and the data suggest that it meets the requirements for further analyses.[4] Table 2.9 displays the results of the EFA, showing which items grouped into common factors, along with their factor loadings, which are a measure of how closely each item is related to the underlying construct (the higher the factor loading the more closely related that item is to the factor in which it has been placed statistically). It also displays the Cronbach's alpha for each scale, which also gives an indication of how closely related to each other the items in a scale are. Generally, Cronbach's alphas above .7 are considered acceptable and above .8 are good. For educational research, particularly involving children, alphas of above .6 are marginally acceptable.

[4] For the EFA the measurements of sampling adequacy were fine (e.g. KMO was .949, which is 'superb'), and the percentage of non-redundant residuals with absolute values greater than .05 was 1.0% (it should be less than 50%). The determinant was 1.10E-005, which is sufficiently large so that multicolliniarity should not be an issue.

Item	Interest in space-related activities	Space science and my future	Preparing for work in space science	Valuing space science	Positive attitudes to space science	Perceptions of jobs / people in space science
Interest in space-related activities						
(How much would you like to do the following things in your spare time?)						
Find out about space online	0.806					
Read about space in books or magazines	0.770					
Watch a TV programme about space	0.756					
Talk with someone else about space	0.646					
Look through a telescope or go star gazing	0.572					
Space science and my future						
I would like to study space science in the future.		0.671				
I would like to have a job related to space.		0.665				
I want to find out more about jobs related to space.		0.560				
People who are like me work in jobs related to space.		0.462				
Preparing for work in space science						
(Space scientists or people who work in jobs related to space):						
had to study for many years to get their jobs.			0.780			
always have university degrees.			0.652			
You have to study science to get a job related to space.			0.405			
Valuing space science						
Understanding about space is important for society.				0.726		
Discoveries in space science can help society in general.				0.549		
It is important to learn about space.				0.529		
Discoveries in space science can make MY life better.				0.394		
Positive attitudes to space science						
Space science is interesting.					-0.425	
I would like to find out more about space.					-0.424	
I enjoy learning about space.					-0.406	
Jobs in space science are boring.[5]					0.346	
Perceptions of jobs / people in space science						
Important discoveries about space have been made by people from many different cultures.						0.707
People from many different countries work together to make discoveries about space.						0.612
It is important that people from many different cultures work in space science.						0.518
It is important that both women and men work in jobs related to space science.						0.504
People with many different jobs work together to make discoveries about space.						0.498
(People who work in jobs related to space) come from many different cultures.						0.459
Important discoveries about space have been made by women.						0.422
There are many kinds of jobs in space science.[6]						(<.300)
Cronbach's alpha	***0.845***	***0.776***	***0.637***	***0.790***	***0.843***	***0.790***

Table 2.9 – Summary of factor loadings of survey items

[5] This item was reverse coded in later analyses (so all of the items in this factor were consistent).

[6] This item had a loading of under .300, but was more closely related to this factor than others. In an attempt to minimise the number of items that were not included in any composite, it was included here. (Also, reliability analyses reflected that it can be included in this factor.)

2.3 Means of composite variables

The means for each composite variable were calculated by firstly adding the scores from each student's response to each item as follows: strongly disagree = 1, disagree = 2, neither = 3, agree = 4, and strongly agree = 5. (For items about 'how much', not at all = 1 and very much = 5.) Then, the scores were added together and divided by the number of items in the variable. This calculation gave each student a score from 1-5 for each composite. (That is, the range is 1-5 – if a student strongly disagreed with all of the items, they would have a mean of 1 on the variable; if they strongly agreed with all of the items, they would have a mean of 5.) Finally, the means for all students were averaged to create a mean score for the composite overall. Because the range of means for each student was 1-5, the composite means also ranged from 1-5.

The means and standard deviations[7] of the final six composite variables are shown in Table 2.10.

Composite variable	Mean	Std deviation
Interest in space-related activities	3.42	1.033
Space science and my future	3.1095	.93716
Positive attitudes to space science	3.8856	.91277
Perceptions of work in space science	3.9339	.61943
Preparing for work in space science	4.0570	.71927
Valuing space science	3.8335	.74735

Table 2.10 – Means and SDs of each of the composite variables

In general, the means and standard deviations found in Table 2.10 suggest that very broadly, students would seem to have positive perceptions of work in space science and value space science, as well as having positive attitudes towards space science (i.e. finding it interesting). To a lesser extent, students were interested in participating in some space-related activities, although there was considerable variability among students (as suggested by the larger size of the SD). However, compared with the other composite variables, there would seem to be less positive attitudes towards 'space science and my future', suggesting less interest from individuals in space science as a personal career direction, or in working in a space-related job.

[7] The standard deviation (SD) is a measure of the variability of the scores around the mean. The larger the SD, the greater the spread of the student means around the overall composite mean.

3. Analyses

This section contains details of the analyses conducted on each composite variable. These analyses were conducted to provide more insight into the data – for instance, they investigate whether there were differences by gender or age or by country on any of the variables (e.g. whether boys and girls responded similarly in terms of their interest in space science-related activities). They also investigate the way in which the different variables are related to each other.

Each subsection presented below covers the analyses for an individual composite, and follows the same systematic approach in each case:

i. Each begins with an overview of the composite (e.g. mean and distribution of scores).
ii. Then, analyses of variance (ANOVAs) were used to explore whether there were overall differences by gender, age or country on the variable.
iii. For age and country, if the overall ANOVA was significant (i.e. showed a difference in means overall by age or by country), post-hoc tests (Bonferroni method) were used to compare groups in pairs (e.g. to compare Spain with France, Spain with Germany, Germany with France and so forth).[8]
iv. Finally, regression analyses were used to explore which variables (background variables and other composite variables) were most closely related to the outcome composite variable (the focus of each section). In doing the analysis, in addition to the background variables, we entered the composite variables most closely related to the outcome variable. All were not entered so that the model would be more parsimonious. We used a cut-off of correlations of .500 or higher between the outcome composite variable and other composites. In the event there were not enough at this level, the two or three composite variables most closely correlated with the dependent variable were entered in the model (depending on how closely related the variables were to the outcome). Two regression analyses were conducted for each outcome variable. The first used the complete dataset and the background variables of age and gender. The second used the smaller dataset of responses only from those countries (including the UK/Ireland combined) with sufficient responses for those analyses (see Table 1.1) and the background variables of age, gender and country.

[8] As noted in section 1.1, due to the varied distribution of our cohort across the age ranges we have weighted for age within these analyses. In the case of comparisons related to country, the UK and Ireland were combined, and non-European countries were excluded, as were countries with insufficient numbers of responses (Belgium, Norway, Netherlands). For the analyses relating to composites that were not related to country (e.g. age and gender), we used the full data set.

3.1 Interest in space-related activities

This composite variable included the following items:

(How much would you like to do the following in your spare time?)

- Find out about space online
- Read about space in books or magazines
- Watch a TV programme about space
- Talk with someone else about space
- Look through a telescope or go star gazing

3.1.1 Overview of the composite 'Interest in space-related activities'

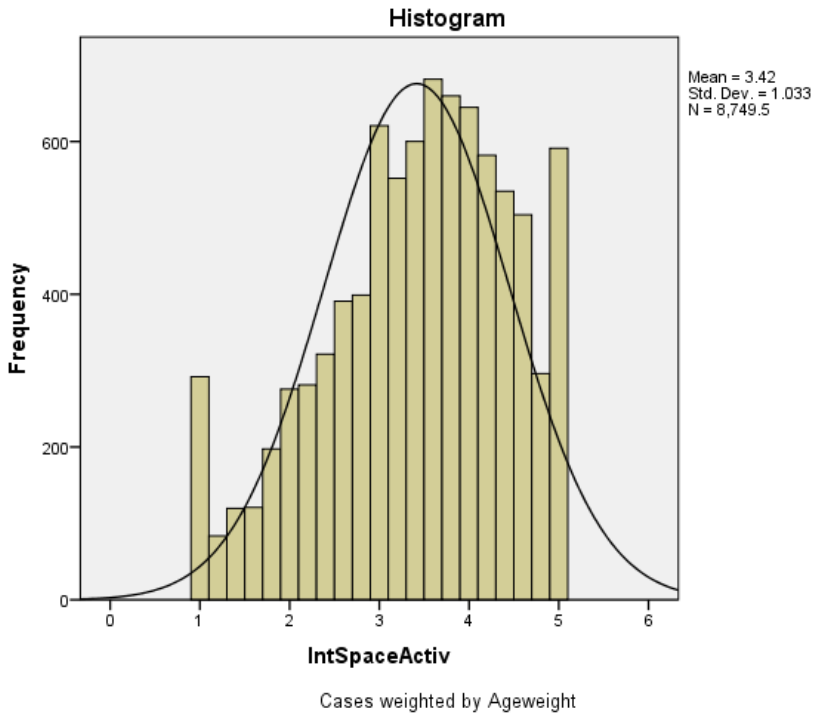

Figure 3.1 – Distribution of means for 'Interest in space-related activities'

3.1.2 Differences by gender for the composite 'Interest in space-related activities'

Gender	N	Mean	SD
Male	4224	3.42	1.054
Female	4468	3.41	1.012
Total	**8692**	**3.41**	**1.033**

Table 3.1 - Summary of differences by gender for the composite variable 'Interest in space-related activities'

Males and females did not differ significantly on this variable (p = .468).

3.1.3 Differences by age for the composite 'Interest in space-related activities'

Age	N	Mean	SD
9 - 10	867	3.69	.985
11	1747	3.50	1.004
12	1737	3.44	1.038
13	1746	3.28	1.041
14	1769	3.32	1.032
15 - 16	883	3.40	1.046
Total	**8749**	**3.42**	**1.033**

Table 3.2 – Summary of differences by age for the composite variable 'Interest in space-related activities'

There was a significant difference on this variable among age groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	126.400	5	25.280	24.002	.000
Within Groups	9208.711	8743	1.053		
Total	**9335.112**	**8748**			

Table 3.3 – One-way ANOVA (Age) for the composite variable 'Interest in space-related activities'

Age (years)	9 - 10	11	12	13	14	15 - 16
9 - 10		*	*	*	*	*
11			X	*	*	X
12				*	*	X
13					X	X
14						X

Table 3.4 - Indications of pairwise significant differences by age for the composite variable 'Interest in space-related activities' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[9]

The mean of 9-10 year olds on this variable was significantly higher than each of the other age groups, suggesting that younger children were more interested in various space-related activities.

[9] Please refer to Table 3.2 for the direction of the differences. For instance, the difference between age 11 and age 13 is significant for this variable. Table 3.2 indicates that the mean for 11-year-olds is 3.50 and the mean for 13-year-olds is 3.28. Thus, the mean for 11-year-olds is significantly higher than the mean for 13-year-olds.

3.1.4 Differences by country for the composite 'Interest in space-related activities'

Country	N	Mean	SD
Bulgaria	612	3.61	.956
Czech Rep	705	3.27	.997
France	1192	3.43	1.026
Germany	562	3.11	1.023
Greece	697	3.53	.931
Italy	560	3.37	.892
Poland	761	3.30	1.112
Portugal	736	3.60	.986
Romania	630	4.11	.794
UK & Ireland	947	3.02	1.133
Spain	495	3.47	.942
Total	**7896**	**3.42**	**1.034**

Table 3.5 – Summary of differences by country for the composite variable 'Interest in space-related activities'

There was a significant difference on this variable among country groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	583.736	10	58.374	58.623	.000
Within Groups	7851.513	7885	.996		
Total	**8435.249**	**7895**			

Table 3.6 One-way ANOVA (Country) for the composite variable 'Interest in space-related activities'

Country	Bulgaria	Czech Rep	France	Germany	Greece	Italy	Poland	Portugal	Romania	UK & Ireland	Spain
Bulgaria		*	*	*	X	*	*	X	*	*	X
Czech Rep			*	X	*	X	X	*	*	*	*
France				*	X	X	X	*	*	*	X
Germany					*	*	X	*	*	X	*
Greece						X	X	*	*	*	X
Italy							X	*	*	*	X
Poland								*	*	*	X
Portugal									*	*	X
Romania										*	*
UK & Ireland											*

Table 3.7 - Indications of pairwise significant differences by country for the composite variable 'Interest in space-related activities' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[10]

The most salient differences here are that the mean score of Romanian students on this composite variable was significantly higher than that of each other country. Conversely, the mean score for the UK/Ireland was significantly lower than that of each other country except Germany. These data therefore indicate that the Romanian students within our sample were significantly more interested in participating in space-related activities in their spare time compared to their peers from other countries. Likewise, students from the UK/Ireland reported being significantly less interested in space-related activities compared to students from other European countries, with the exception of Germany. They did not go so far as to indicate an active lack of interest in space-related activities though: the composite mean score was still just over 3 (indicating they would like to do the activities indicated 'a little' in their spare time, rather than 2 'not much' or 1 'not at all').

[10] Please refer to Table 3.5 for the direction of the differences.

3.1.5 Regression for the composite 'Interest in space-related activities'

Table 3.8 shows the regression model for Interest in space related activities. That is, it shows which variables are most closely related to the dependent variable.[11]

	Coefficient (B)	SE	Beta (std)[12]
Intercept (constant)	-.164	.049	
Gender (female) [Ref: Male][13]	.044	.015	.021
Age 9-11 [Ref: Age 15-16]	.067	.027	.030
Space Science and my future	.315	.011	.286
Positive attitudes to space science	.497	.012	.439
Valuing space science	.169	.013	.122

Table 3.8 – Effects of background and composite variables on 'Interest in space-related activities'

The adjusted R^2 for this model is .562, indicating that 56.2% of the variance in the outcome variable is accounted for by the variables listed in the first column of Table 3.8. The beta weights indicate that 'Positive attitudes to space science' (another composite variable) is the variable most closely related to 'Interests in space-related activities', once other variables are controlled for. This is followed by 'Space science and my future' (composite) and 'Valuing space science' (composite). Being in the age group 9-11 and being female are also significantly related to the outcome, with females being more interested in space-related activities than males, once other variables are held constant. (9-11 year olds are also more interested, compared to 15-16 year olds.)

Next, a second regression analysis was conducted which used the smaller dataset (data only from students in the countries with sufficient numbers of responses), which also included the country background variable. The results of that analysis are presented in Table 3.9.

[11] Only variables significantly related to the DV are included in the table.

[12] The column labelled 'beta' contains standardised measures of how closely each variable is related to the dependent variable – the higher the number, the stronger the relationship, which can be either positive or negative.

[13] For categorical variables (e.g. gender, age, country), dummy variables (1 = category member, 0 = non-member) are created and entered into the regression analysis. However, there is always a reference category variable, which is not entered. So, here, males were used as the reference category – so if gender is significantly related to the dependent variable (and thus included in the model), it means being female (or that variable) was significantly related.

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	-.130	.050	
Gender (female) [Ref: Male]	.040	.015	.019
Age 9-11 [Ref: Age 15-16]	.096	.027	.042
Bulgaria[14]	.115	.032	.028
Czech Republic	.084	.030	.022
Greece	.144	.031	.037
Italy	-.138	.034	-.032
Portugal	.079	.029	.021
Romania	.369	.032	.092
UK/Ireland	-.190	.031	-.050
Space science and my future	.302	.012	.275
Positive attitudes to space science	.498	.012	.440
Valuing space science	.155	.013	.111

Table 3.9 – Effects of background (including country) and composite variables on 'Interest in space-related activities'

The adjusted R^2 for this model is .577, indicating that 57.7% of the variance in the outcome variable is accounted for by the variables listed in the first column of Table 3.9. In this model, the beta weights indicate that 'Positive attitudes to space science' (another composite variable) is the variable most closely related to 'Interest in space-related activities', once other variables are controlled for. This is followed by 'Space science and my future' (composite) and 'Valuing space science' (composite). Being in the age group 9-11 and being female are also significantly related to the outcome, with females being more interested in space-related activities than males, once other variables are held constant. (9-11 year olds are also more interested, compared to 15-16 year olds.) Finally, being from Bulgaria, Czech Republic, Greece, Italy, Portugal, Romania and the UK/Ireland (combined) are also significantly related to the dependent variable. In particular, the analyses reflected that UK/Ireland and Italy were negatively related to Interest in space science activities (less interest, controlling for other variables), while Bulgaria, Czech Republic, Greece, Portugal, and Romania are positively related (more interest).

[14] The reference category for the country variables is France (because it had the largest number of participants).

3.2 Space science and my future

This composite variable included the following items:

(How much do you agree with these sentences?)

- I would like to study space science in the future.
- I would like to have a job related to space.
- I want to find out more about jobs related to space.
- People who are like me work in jobs related to space.

3.2.1 Overview of the composite 'Space science and my future'

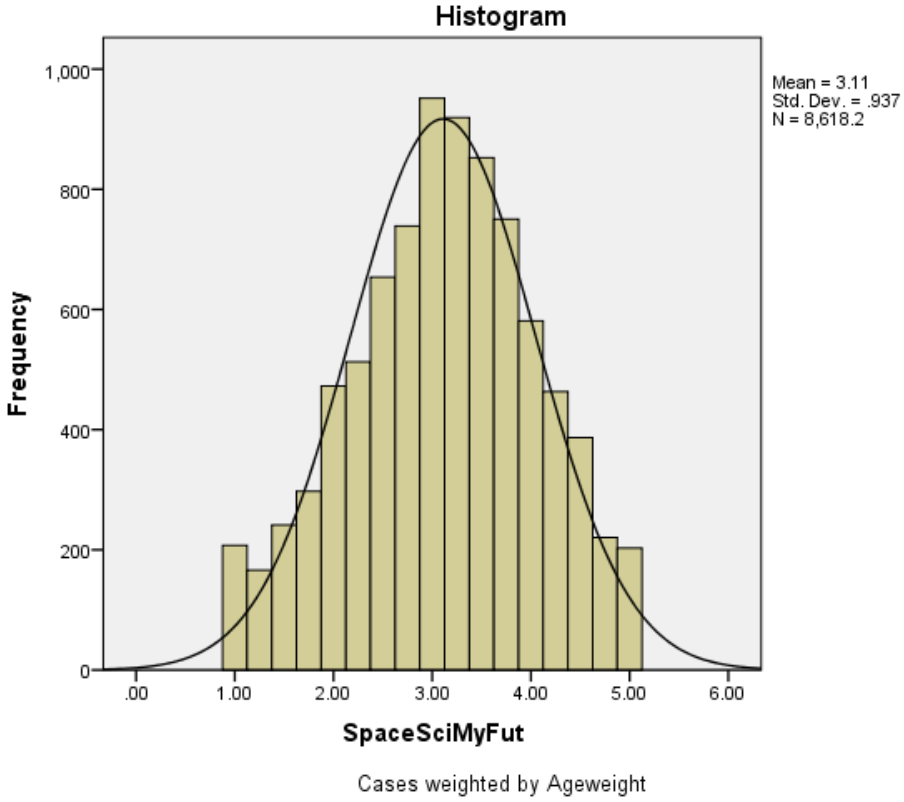

Figure 3.2 – Distribution of means for 'Space science and my future'

3.2.2 Differences by gender for the composite 'Space science and my future'

Gender	N	Mean	SD
Male	4170	3.1720	.96040
Female	4391	3.0494	.90950
Total	**8561**	**3.1091**	**.93659**

Table 3.10 – Summary of differences by gender for the composite variable 'Space science and my future'

There was a significant difference on this variable between groups, $t(8559) = 6.065$, $p < .0001$. (Here, a t-test was used to compare means because there are only two groups but an ANOVA gave the same significant result.)

Due to the interest in Space Awareness in gender effects, further analyses were used to explore whether these patterns (of males having higher means than females on this variable) held across individual countries. T-tests for individual countries reflected that, indeed, this difference held true in nearly half of the countries participating. In particular, the mean score for males on this variable was significantly higher than for females in the following countries: France, Germany, UK/Ireland, Portugal and Spain. There was no significant difference by gender in Bulgaria, the Czech Republic, Poland, Romania, Greece and Italy. This suggests that for some countries (notably those in northern Europe), males are more likely to aspire to careers in space science than females.

3.2.3 Differences by age for the composite 'Space science and my future'

Age	N	Mean	SD
9 - 10	855	3.3855	.92429
11	1723	3.1677	.94399
12	1722	3.1495	.88978
13	1731	3.0005	.95072
14	1711	3.0106	.93332
15 - 16	878	3.0554	.94087
Total	**8618**	**3.1095**	**.93716**

Table 3.11 – Summary of differences by age for the composite variable 'Space science and my future'

There was a significant difference on this variable among age groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	113.571	5	22.714	26.240	.000
Within Groups	7454.668	8612	.866		
Total	**7568.239**	**8617**			

Table 3.12 - One-way ANOVA (Age) for the composite variable 'Space science and my future'

Age (years)	9 - 10	11	12	13	14	15 - 16
9 - 10		*	*	*	*	*
11			X	*	*	X
12				*	*	X
13					X	X
14						X

Table 3.13 - Indications of pairwise significant differences by age for the composite variable 'Space science and my future' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[15]

The mean of 9-10 year olds on this variable was significantly higher than each of the other age groups, suggesting that younger children were more positive about space science in their future (e.g. careers), compared with older children.

3.2.4 Differences by country for the composite 'Space science and my future'

Country	N	Mean	SD
Bulgaria	601	3.3263	.86808
Czech Rep	689	2.7099	.91396
France	1172	3.1462	.98244
Germany	551	2.6310	.94198
Greece	691	3.0093	.92057
Italy	550	3.4397	.72096
Poland	759	3.0188	.89741
Portugal	730	3.3255	.82633
Romania	621	3.7039	.78076
UK & Ireland	928	2.9976	.89250
Spain	482	3.1436	.86463
Total	**7773**	**3.1246**	**.92857**

Table 3.14 – Summary of differences by country for the composite variable 'Space science and my future'

[15] Please refer to Table 3.11 for the direction of the differences.

There was a significant difference on this variable among country groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	602.921	10	60.292	76.734	.000
Within Groups	6098.822	7762	.786		
Total	6701.743	7772			

Table 3.15 - One-way ANOVA (Country) for the composite variable 'Space science and my future'

Country	Bulgaria	Czech Rep	France	Germany	Greece	Italy	Poland	Portugal	Romania	UK & Ireland	Spain
Bulgaria		*	*	*	*	X	*	X	*	*	*
Czech Rep			*	X	*	*	*	*	*	*	*
France				*	X	*	X	*	*	*	X
Germany					*	*	*	*	*	*	*
Greece						*	X	*	*	X	X
Italy							*	X	*	*	*
Poland								*	*	X	X
Portugal									*	*	*
Romania										*	*
UK & Ireland											X

Table 3.16 - Indications of pairwise significant differences by country for the composite variable 'Space science and my future' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[16]

The most salient differences here are that the mean score of Romanian students on this composite variable was significantly higher than that of each other country. Conversely, the mean scores for the Czech Republic and for Germany were significantly lower than those of each other country (except each other). This means that Romanian students were significantly more likely than their peers from other countries to consider space science as a potential area of study or career for them personally. Conversely, Czech and German students tended to 'disagree' with such proposals.

[16] Please refer to Table 3.14 for the direction of the differences.

3.2.5 Regression for the composite 'Space science and my future'

Table 3.17 shows the regression model for the composite variable 'Space science and my future'. That is, it shows which variables are most closely related to this dependent variable.[17]

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	-.143	.045	
Gender (female) [Ref: Male]	-.105	.014	-.056
Age 9-11 [Ref: Age 15-16]	.113	.026	.055
Interest in space science activities	.273	.010	.300
Positive attitudes to space science	.371	.011	.360
Valuing space science	.226	.012	.179

Table 3.17 – Effects of background and composite variables on 'Space science and my future'

The adjusted R^2 for this model is .540, indicating that 54.0% of the variance in the outcome variable is accounted for by the variables listed in the first column of Table 3.17. The beta weights indicate that 'Positive attitudes to space science' (another composite variable) is the variable most closely related to 'Space science and my future', controlling for other variables. This is followed by 'Interest in space science activities' (composite) and 'Valuing space science' (composite). Being in the age group 9-11 and being female are also significantly related to the outcome: females are likely to have lower scores on this dependent variable than males, once other variables are held constant. 9-11 year olds are likely to score more highly on this outcome variable, compared to older students. What this means is that assuming all other aspects are held constant, females are less likely than males to see space science as being of relevance to their own personal future direction. Conversely, 9-11 year olds are significantly more likely to consider space science as part of their future in comparison to older students.

Next, a second regression analysis was conducted which used the smaller dataset (data from students in the countries with sufficient numbers of responses), which also included the country background variable. The results of that analysis are presented in Table 3.18.

[17] Only variables significantly related to the DV are included in the table.

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	-.029	.049	
Gender (female) [Ref: Male]	-.120	.014	-.065
Age 9-11 [Ref: Age 15-16]	.116	.026	.057
Age 12-14 [Ref: Age 15-16]	.050	.024	.026
Bulgaria	.100	.031	.028
Czech Republic	-.296	.029	-.091
Germany	-.342	.032	-.095
Greece	-.170	.030	-.051
Italy	.323	.032	.088
Romania	.250	.031	.073
UK/Ireland	.059	.030	.018
Interest in space science activities	.239	.010	.265
Positive attitudes to space science	.370	.012	.360
Valuing space science	.232	.012	.185

Table 3.18 – Effects of background (including country) and composite variables on 'Space science and my future'

The adjusted R^2 for this model is .569, indicating that 56.9% of the variance in the outcome variable is accounted for by the variables in the first column of Table 3.18. In this model, the beta weights indicate that 'Positive attitudes to space science' (another composite variable) is the variable most closely related to 'Space science and my future', after controlling for other variables. This is followed by 'Interest in space science-related activities' (composite) and 'Valuing space science' (composite). Being younger (especially in the age 9-11 group) is also associated with higher means on this variable. Being female, however, is negatively associated with the outcome – females are less likely to identify with space science as part of their future aspirations or plans. Finally, some countries are also associated with this outcome – some (Bulgaria, Italy, Romania and UK/Ireland) in a positive direction (students from these countries being more likely to see space science in their future) and others (Czech Republic, Germany and Greece) in a negative direction.

3.3 Positive attitudes to space science

This composite variable included the following items:

(How much do you agree with these sentences?)

- Space science is interesting.
- I would like to find out more about space.
- I enjoy learning about space.
- Jobs in space science are boring.

3.3.1 Overview of the composite 'Positive attitudes to space science'

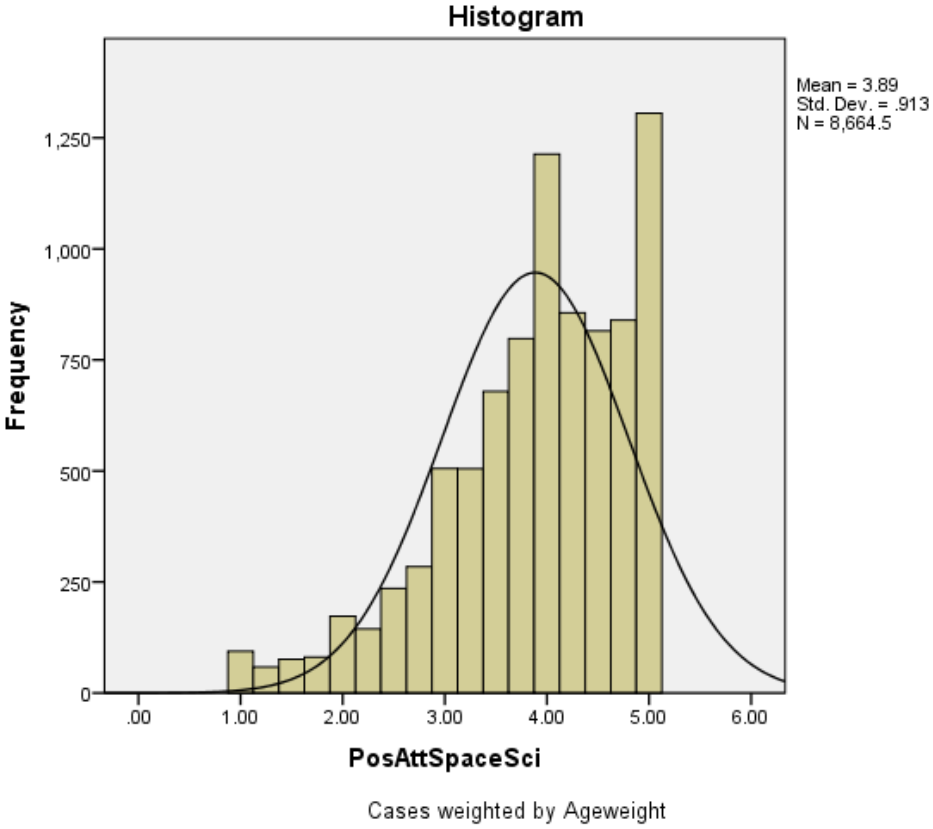

Table 3.19 – Distribution of means for 'Positive attitudes to space science'

3.3.2 *Differences by gender for the composite 'Positive attitudes to space science'*

Gender	N	Mean	SD
Male	4190	3.8998	.92593
Female	4417	3.8734	.89913
Total	**8607**	**3.8862**	**.91232**

Table 3.20 – Summary of differences by gender for the composite variable 'Positive attitudes to space science'

Males and females did not differ significantly on this variable (p=.181). Interestingly, though, although there was not a significant difference across the sample as a whole, at the country level, some gender differences did appear on this variable. More specifically, t-tests revealed that males had significantly more positive attitudes to space science than females in France and in Spain (and this trend approached, but did not reach, significance in the UK/Ireland sample). In contrast, females had significantly more positive attitudes to space science than males in Romania and Greece.

3.3.3 *Differences by age for the composite 'Positive attitudes to space science'*

Age	N	Mean	SD
9 - 10	865	4.0893	.85793
11	1728	3.9110	.94200
12	1725	3.9204	.87710
13	1732	3.7894	.92167
14	1735	3.8204	.91688
15 - 16	880	3.8854	.91323
Total	**8665**	**3.8856**	**.91277**

Table 3.21 – Summary of differences by age for the composite variable 'Positive attitudes to space science'

There was a significant difference on this variable among age groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	62.487	5	12.497	15.121	.000
Within Groups	7155.575	8658	.826		
Total	**7218.062**	**8663**			

Table 3.22 – One-way ANOVA (Age) for the composite variable 'Positive attitudes to space science'

Age (years)	9 - 10	11	12	13	14	15 - 16
9 - 10		*	*	*	*	*
11			X	*	X	X
12				*	*	X
13					X	X
14						X

Table 3.23 - Indications of pairwise significant differences by age for the composite variable 'Positive attitudes to space science' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[18]

The mean of 9-10 year olds on this variable was significantly higher than each of the other age groups, suggesting that younger children had more positive attitudes to space science than older age groups.

3.3.4 Differences by country for the composite 'Positive attitudes to space science'

Country	N	Mean	SD
Bulgaria	609	3.9550	.79917
Czech Rep	695	3.7631	.94464
France	1189	3.9792	.96088
Germany	558	3.8092	.96482
Greece	677	3.9937	.89918
Italy	558	4.0106	.71433
Poland	754	3.6828	.96258
Portugal	735	3.9800	.81968
Romania	621	4.2167	.73652
UK & Ireland	924	3.7103	.97678
Spain	488	3.9015	.87434
Total	**7809**	**3.9031**	**.90607**

Table 3.24 – Summary of differences by country for the composite variable 'Positive attitudes to space science'

[18] Please refer to Table 3.21 for the direction of the differences.

There was a significant difference on this variable among country groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	175.401	10	17.540	21.936	.000
Within Groups	6234.378	7797	.800		
Total	6409.778	7807			

Table 3.25 – One-way ANOVA (Country) for the composite variable 'Positive attitudes to space science'

Country	Bulgaria	Czech Rep	France	Germany	Greece	Italy	Poland	Portugal	Romania	UK & Ireland	Spain
Bulgaria		*	X	X	X	X	*	X	*	*	*
Czech Rep			*	X	*	*	X	*	*	X	X
France				*	X	X	*	X	*	*	X
Germany					*	*	X	*	*	X	X
Greece						X	*	X	*	*	X
Italy							*	X	*	*	X
Poland								*	*	X	*
Portugal									*	*	X
Romania										*	*
UK & Ireland											X

Table 3.26 - Indications of pairwise significant differences by country for the composite variable 'Positive attitudes to space science' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[19]

The most salient differences here are that the mean score of Romanian students on this composite variable was significantly higher than that of each other country. This means that Romanian students were significantly more likely than their international peers to report positive attitudes towards space science.

[19] Please refer to Table 3.24 for the direction of the differences.

3.3.5 Regression for the composite 'Positive attitudes to space science'

Table 3.27 shows the regression model for the composite variable 'Positive attitudes to space science'. That is, it shows which variables are most closely related to this dependent variable.[20]

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	.459	.048	
Interest in space science activities	.347	.009	.392
Space science and my future	.301	.010	.309
Perceptions of work in space science	.190	.013	.128
Valuing space science	.149	.012	.121

Table 3.27 – Effects of background and composite variables on 'Positive attitudes to space science'

The adjusted R^2 for this model is .611, indicating that 61.1% of the variance in the outcome variable is accounted for by the variables listed in the first column ofTable 3.27. The beta weights indicate that 'Interest in space science-related activities' (another composite variable) is the variable most closely related to 'Positive attitudes to space science', controlling for other variables. This is followed by 'Space science and my future' (composite) and then, less strongly (but still significant) 'Perceptions of work in space science' and 'Valuing space science'. After controlling for other variables, none of the background variables (age, gender) were sufficiently closely related to be included in the model. (That is, none were significantly related to the outcome.) This is partly due to the inclusion of four composite variables in this model but also may be because there was simply relatively little variation in the means – suggesting that regardless of age or gender, students tended to have generally positive attitudes to space science.

Next, a second regression analysis was conducted which used the smaller dataset (data from students in the countries with sufficient numbers of responses), which also included the country background variable. The results of that analysis are presented in Table 3.28.

[20] Only variables significantly related to the DV are included in the table.

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	.496	.056	
Bulgaria	-.085	.030	-.024
Germany	.170	.030	.049
Greece	.073	.028	.022
Poland	-.099	.027	-.033
Portugal	-.106	.027	-.034
Romania	-.165	.030	-.049
Spain	-.070	.031	-.019
Interest in space science activities	.354	.009	.403
Space science and my future	.314	.010	.321
Perceptions of work in space science	.155	.014	.104
Valuing space science	.166	.012	.136

Table 3.28 – Effects of background (including country) and composite variables on 'Positive attitudes to space science'

The adjusted R^2 for this model is .615, indicating that 61.5% of the variance in the outcome variable is accounted for by the variables listed in the first column of Table 3.28. In this model, the beta weights indicate that 'Interest in space science-related activities' (another composite variable) is the variable most closely related to 'Positive attitudes to space science', controlling for other variables. This is followed by 'Space science and my future' (composite) and then, less strongly (but still significant) 'Perceptions of work in space science' and 'Valuing space science'. Likewise, neither gender nor age is sufficiently closely related to attitudes to space science to be included in the model. However, some country variables are related – in particular Germany and Greece (in a positive direction, compared to France) and Bulgaria, Poland, Portugal, Romania and Spain in a negative direction. It is important to note here that this may seem to contradict the means for each country found in Table 3.23. However, the regression analysis holds other variables constant – meaning that while overall one country may have a higher mean than another, the pattern may shift once other variables (including composite variables) are taken into account.

3.4 Perceptions of work in space science

This composite variable included the following items:

(How much do you agree with these sentences?)

- Important discoveries about space have been made by people from many different cultures.
- People from many different countries work together to make discoveries about space.
- It is important that people from many different cultures work in space science.
- It is important that both women and men work in jobs related to space science.
- People with many different jobs work together to make discoveries about space.
- (People who work in jobs related to space) come from many different cultures.
- Important discoveries about space have been made by women.
- There are many kinds of jobs in space science.

3.4.1 Overview of the composite 'Perceptions of work in space science'

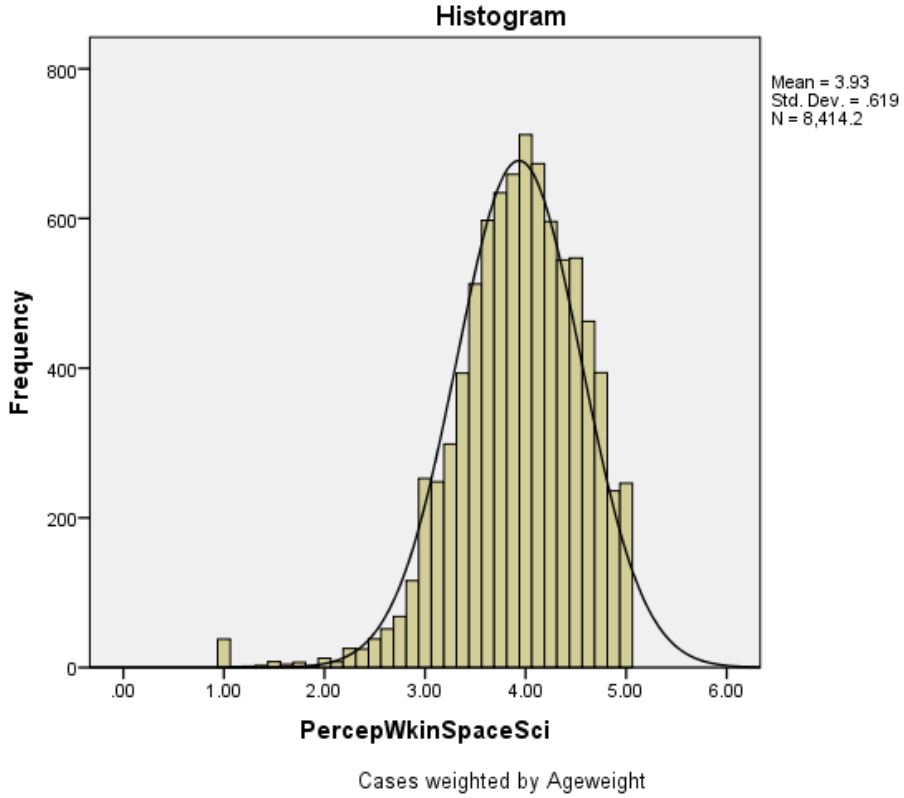

Figure 3.3 – Distribution of means for 'Perceptions of work in space science'

3.4.2 Differences by gender for the composite 'Perceptions of work in space science'

Gender	N	Mean	SD
Male	4060	3.9086	.65140
Female	4300	3.9585	.58366
Total	**8360**	**3.9343**	**.61795**

Table 3.29 – Summary of differences by gender for the composite variable 'Perceptions of work in space science'

There was a significant difference on this variable between groups, $t(8358) = -3.694$, $p < .0001$, with the means for females being higher than that for males. (Here, a t-test was used to compare means because there are only two groups but an ANOVA gave the same significant result.)

Due to the interest in Space Awareness in gender effects, further analyses were used to explore whether these patterns (of females having higher means than males on this variable) held across individual countries. T-tests for individual countries reflected that this difference held true in some but not all of the countries participating. In particular, the mean score for *females* on this variable was significantly higher than for males in Poland, UK/Ireland and Greece and this difference approached significance for the Czech Republic and Romania. In contrast, the mean score for *males* was higher than for females in Portugal. This pattern suggests that, in the main, females do have perceptions of space science as a field in which a range of individuals (male and females, from many different cultures) work, can work and should work. (That is, they agree that it is important that people from different countries and of different genders work in space science). Additionally, the item on which the greatest gender differences appeared (across the sample) was: 'It is important that both men and women work in jobs related to space science' (83% of females and 75% of males agreed). Overall, though, it would seem that it is not negative perceptions of who can work in space science that is driving girls' lower scores on the 'Space science and my future variable'. That is, girls' weaker aspirations towards careers in space science would not seem to be due to negative perceptions of work in that field.

3.4.3 Differences by age for the composite 'Perceptions of work in space science'

Age	N	Mean	SD
9 - 10	837	3.9000	.64041
11	1670	3.8704	.60936
12	1679	3.9927	.62362
13	1670	3.9290	.62415
14	1701	3.9703	.59269
15 - 16	857	3.9131	.63879
Total	**8414**	**3.9339**	**.61943**

Table 3.30 – Summary of differences by age for the composite variable 'Perceptions of work in space science'

There was a significant difference on this variable among age groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16.182	5	3.236	8.472	.000
Within Groups	3211.884	8408	.382		
Total	3228.066	8413			

Table 3.31 – One-way ANOVA (Age) for the composite variable 'Perceptions of work in space science'

Age (years)	9 - 10	11	12	13	14	15 - 16
9 - 10		X	*	X	X	X
11			*	X	*	X
12				*	X	*
13					X	X
14						X

Table 3.32 - Indications of pairwise significant differences by age for the composite variable 'Perceptions of work in space science' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[21]

Interestingly, 12 year olds were the most likely to agree with statements in this composite variable (about perceptions of work in space science), closely followed by 14 year olds, while 11 year olds were least likely to agree. However, it is worth noting that age differences on this composite were quite small.

[21] Please refer to Table 3.30 for the direction of the differences.

3.4.4 Differences by country for the composite 'Perceptions of work in space science'

Country	N	Mean	SD
Bulgaria	575	3.7712	.60810
Czech Rep	678	4.0288	.61795
France	1163	4.2138	.59584
Germany	539	3.8756	.60368
Greece	653	4.0157	.57850
Italy	536	3.8747	.50746
Poland	744	3.6551	.64855
Portugal	715	3.9086	.56098
Romania	603	3.9699	.52809
UK & Ireland	910	3.9111	.65965
Spain	477	4.0931	.57902
Total	**7593**	**3.9521**	**.61647**

Table 3.33 – Summary of differences by country for the composite variable 'Perceptions of work in space science'

There was a significant difference on this variable among country groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	189.674	10	18.967	53.344	.000
Within Groups	2695.538	7581	.356		
Total	**2885.212**	**7591**			

Table 3.34 – One-way ANOVA (Country) for the composite variable 'Perceptions of work in space science'

Country	Bulgaria	Czech Rep	France	Germany	Greece	Italy	Poland	Portugal	Romania	UK & Ireland	Spain
Bulgaria		*	*	X	*	X	*	*	*	*	*
Czech Rep			*	*	X	*	*	*	X	*	X
France				*	*	*	*	*	*	*	*
Germany					*	X	*	X	X	X	*
Greece						*	*	*	X	*	X
Italy							*	X	X	X	*
Poland								*	*	*	*
Portugal									X	X	*
Romania										X	*
UK & Ireland											*

Table 3.35 - Indications of pairwise significant differences by country for the composite variable 'Perceptions of work in space science' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[22]

The most salient differences here are that the mean score of French students on this composite variable was significantly higher than that of each other country. Conversely, the mean score for Poland was significantly lower than that of each other country. These results indicate that French students were significantly more likely to agree with the statements associated with 'Perceptions of work in space science' compared to their international peers. In contrast, Polish students, though still tending towards agreeing generally, reported significantly lower ratings for those statements.

[22] Please refer to Table 3.33 for the direction of the differences.

3.4.5 Regression for the composite 'Perceptions of work in space science'

Table 3.36 shows the regression model for the composite variable 'Perceptions of work in space science'. That is, it shows which variables are most closely related to this dependent variable.[23]

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	1.959	.036	
Gender (female) [Ref: Male]	.060	.011	.041
Age 12-14 [Ref: Age 15-16]	.079	.019	.063
Positive attitudes to space science	.169	.007	.250
Valuing space science	.326	.009	.393

Table 3.36 – Effects of background and composite variables on 'Perceptions of work in space science'

The adjusted R^2 for this model is .331, indicating that 33.1% of the variance in the outcome variable is accounted for by the variables listed in the first column of Table 3.36. The beta weights indicate that 'Valuing space science' (another composite variable) is the variable most closely related to 'Perceptions of work in space science', controlling for other variables. This is followed by 'Positive attitudes to space science'. In addition, being female and being in the middle age range were significantly related to the dependent variable, both in a positive direction. This indicates that females and those aged 12-14 had a significantly higher likelihood of agreeing with the statements relating to 'Perceptions of work in space science'.

Next, a second regression analysis was conducted which used the smaller dataset (data from students in the countries with sufficient numbers of responses), which also included the country background variable. The results of that analysis are presented in Table 3.37.

[23] Only variables significantly related to the DV are included in the table.

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	2.207	.039	
Gender (female) [Ref: Male]	.073	.011	.059
Age 9-11 [Ref: Age 15-16]	-.068	.021	-.051
Bulgaria	-.437	.024	-.187
Czech Republic	.089	.023	-.041
Germany	-.251	.025	-.105
Greece	-.135	.024	-.060
Italy	-.233	.025	-.097
Poland	-.451	.022	-.218
Portugal	-.343	.022	-.164
Romania	-.323	.024	-.141
UK/Ireland	-.187	.023	-.086
Spain	-.101	.026	-.040
Positive attitudes to space science	.162	.008	.238
Valuing space science	.338	.009	.407

Table 3.37 – Effects of background (including country) and composite variables on Perceptions of work in space science

The adjusted R^2 for this model is .388, indicating that 38.8% of the variance in the outcome variable is accounted for by the variables listed in the first column of Table 3.37. In this model, the beta weights indicate that 'Valuing space science' (another composite variable) is the variable most closely related to 'Perceptions of work in space science', followed by 'Positive attitudes to space science', controlling for other variables. Likewise, being female is also positively related to the dependent variable. In this model, the youngest age group (9-11) is also significantly related to 'Perceptions of work in space science', but in a negative direction. In addition, all of the country variables are significant (note that the reference group is France, so it is not in the model). They are all negatively related to the outcome, but this is consistent with the mean of France being higher than the mean of each other country (see Table 3.35). These results indicate that females were more likely to agree with the statements within the 'Perceptions of work in space science' variable. Conversely, those aged 9-11 were significantly less likely to agree with those statements within this dataset. Students from France were significantly more likely to agree with the indicated statements than their international peers.

3.5 Preparing for work in space science

This composite variable included the following items:

(How much do you agree with these sentences?)

- (People who work in jobs related to space): had to study for many years to get their jobs.
- (People who work in jobs related to space): always have university degrees.
- You have to study science to get a job related to space.

3.5.1 Overview of the composite 'Preparing for work in space science'

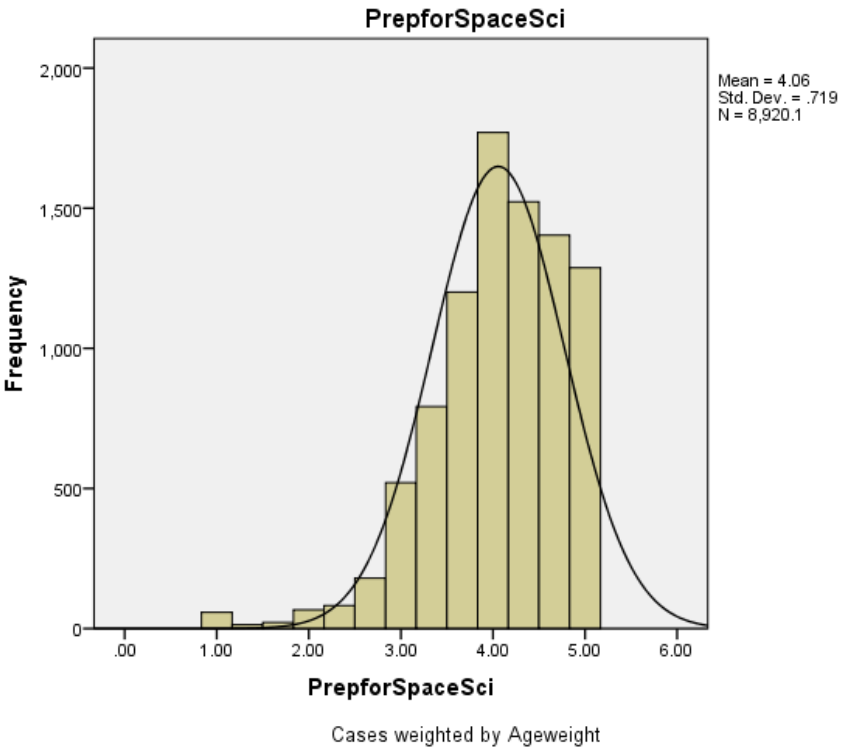

Figure 3.4 – Distribution of means for 'Preparing for work in space science'

3.5.2 Differences by gender for the composite 'Preparing for work in space science'

Gender	N	Mean	SD
Male	4302	4.0700	.75715
Female	4557	4.0450	.68028
Total	**8859**	**4.0571**	**.71871**

Table 3.38 – Summary of differences by gender for the composite variable 'Preparing for work in space science'

Males and females did not differ significantly on this variable (p = .181).

3.5.3 Differences by age for the composite 'Preparing for work in space science'

Age	N	Mean	SD
9 - 10	884	4.1398	.76484
11	1779	4.1102	.68580
12	1779	4.0769	.71816
13	1793	4.0299	.71862
14	1787	4.0298	.69302
15 - 16	898	3.9391	.77178
Total	**8920**	**4.0570**	**.71927**

Table 3.39 – Summary of differences by age for the composite variable 'Preparing for work in space science'

There was a significant difference on this variable among age groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	26.918	5	5.384	10.461	.000
Within Groups	4587.377	8914	.515		
Total	**4614.295**	**8919**			

Table 3.40 – One-way ANOVA (Age) for the composite variable 'Preparing for work in space science'

Age (years)	9 - 10	11	12	13	14	15 - 16
9 - 10		X	X	*	*	*
11			X	*	*	*
12				X	X	*
13					X	*
14						*

Table 3.41 - Indications of pairwise significant differences by age for the composite variable 'Preparing for work in space science' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[24]

The mean of 15-16 year olds was significantly lower than each other age group, meaning they were less likely to agree with the statements comprising this composite (e.g. space scientists had to study for many years to get their job). Similarly, the means for ages 14 and 13 were also both significantly lower than those for age 9-10 and age 11.

[24] Please refer to Table 3.39 for the direction of the differences.

3.5.4 Differences by country for the composite 'Preparing for work in space science'

Country	N	Mean	SD
Bulgaria	630	4.0479	.68423
Czech Rep	713	3.9393	.71352
France	1216	4.3271	.64619
Germany	571	3.7782	.77750
Greece	689	3.9414	.66952
Italy	568	4.1342	.59515
Poland	770	3.8749	.78708
Portugal	752	4.1844	.65994
Romania	650	4.4028	.59425
UK & Ireland	976	3.9165	.72178
Spain	502	4.2735	.66033
Total	**8036**	**4.0814**	**.71308**

Table 3.42 – Summary of differences by country for the composite variable 'Preparing for work in space science'

There was a significant difference on this variable among country groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	309.078	10	30.908	65.671	.000
Within Groups	3776.464	8024	.471		
Total	**4085.541**	**8034**			

Table 3.43 – One-way ANOVA (Country) for the composite variable 'Preparing for work in space science'

Country	Bulgaria	Czech Rep	France	Germany	Greece	Italy	Poland	Portugal	Romania	UK & Ireland	Spain
Bulgaria		X	*	*	X	X	*	*	*	*	*
Czech Rep			*	*	X	*	X	*	*	X	*
France				*	*	*	*	*	X	*	X
Germany					*	*	X	*	*	*	*
Greece						*	X	*	*	X	*
Italy							*	X	*	*	X
Poland								*	*	X	*
Portugal									*	*	X
Romania										*	X
UK & Ireland											*

Table 3.44 - Indications of pairwise significant differences by country for the composite variable 'Preparing for work in space science' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[25]

The most salient difference here is that the mean score of German students on this variable is significantly lower (indicating less agreement) than that of each other country, with the exception of Poland (from whom it did not differ.) Though the mean scores were overall relatively high (closest to 'agree' for all countries), German students were slightly more neutral in their responses than their international peers.

[25] Please refer to Table 3.42 for the direction of the differences.

3.5.5 Regression for the composite 'Preparing for work in space science'

Table 3.45 shows the regression model for the composite variable 'Preparing for work in space science'. That is, it shows which variables are most closely related to this dependent variable.[26]

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	2.176	.051	
Gender (female) [Ref: Male]	-.050	.014	-.035
Age 9-11 [Ref: Age 15-16]	.200	.026	.127
Age 12-14 [Ref: Age 15-16]	.078	.024	.053
Perceptions of work in space science	.459	.012	.397

Table 3.45 – Effects of background and composite variables on 'Preparing for work in space science'

The adjusted R^2 for this model is .162, indicating that 16.2% of the variance in the outcome variable is accounted for by the variables listed in the first column of Table 3.45. This is really quite low, suggesting that a lot of how students respond to these items is accounted for by factors that we were unable to measure. (Generally such factors are related to variation among individuals, e.g. in terms of their unique experiences, personalities and so forth.) The beta weights indicate that 'Perceptions of work in space science' is most closely related to this dependent variable. In addition, being female is negatively related (females were more likely to disagree with the items in this composite, holding other variables constant). Finally, being in the younger age groups was associated with more agreement with the items, relative to being in the 15-16 year old age group.

Next, a second regression analysis was conducted which used the smaller dataset (data from students in the countries with sufficient numbers of responses), which also included the country background variable. The results of that analysis are presented in Table 3.46.

[26] Only variables significantly related to the DV are included in the table.

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	2.328	.059	
Gender (female) [Ref: Male]	-.059	.015	-.041
Age 9-11 [Ref: Age 15-16]	.174	.027	.112
Age 12-14 [Ref: Age 15-16]	.057	.025	.039
Czech Republic	-.209	.030	-.084
Germany	-.289	.033	-.105
Greece	-.239	.031	-.094
Poland	-.121	.030	-.051
Portugal	.068	.030	.028
Romania	.271	.031	.103
UK/Ireland	-.125	.031	-.050
Spain	.082	.034	.028
Perceptions of work in space science	.443	.012	.384

Table 3.46 – Effects of background (including country) and composite variables on Preparing for work in space science

The adjusted R^2 for this model is .202, indicating that 20.2% of the variance in the outcome variable is accounted for by the variables listed in the first column of Table 3.46. In this model, the beta weights indicate that 'Perceptions of work in space science' (another composite variable) is the variable most closely related to 'Preparing for work in space science'. Likewise, being female is also negatively related to the dependent variable, while being in the younger two age groups is positively related to the DV. Finally, most country variables were sufficiently closely related to the dependent variable to be included in the model. In particular, variables for Czech Republic, Germany, Greece, Poland and UK/Ireland were negatively related to 'Preparing for work in space science' (suggesting that students in these countries were less likely to agree with items such as 'You have to study science to get a job related to space'). In contrast, variables for Portugal, Romania and Spain were positively related to the outcome variable.

3.6 Valuing space science

This composite variable included the following items:

(How much do you agree with these sentences?)

- Understanding about space is important for society.
- Discoveries in space science can help society in general.
- It is important to learn about space.
- Discoveries in space science can make MY life better.

3.6.1 Overview of the composite 'Valuing space science'

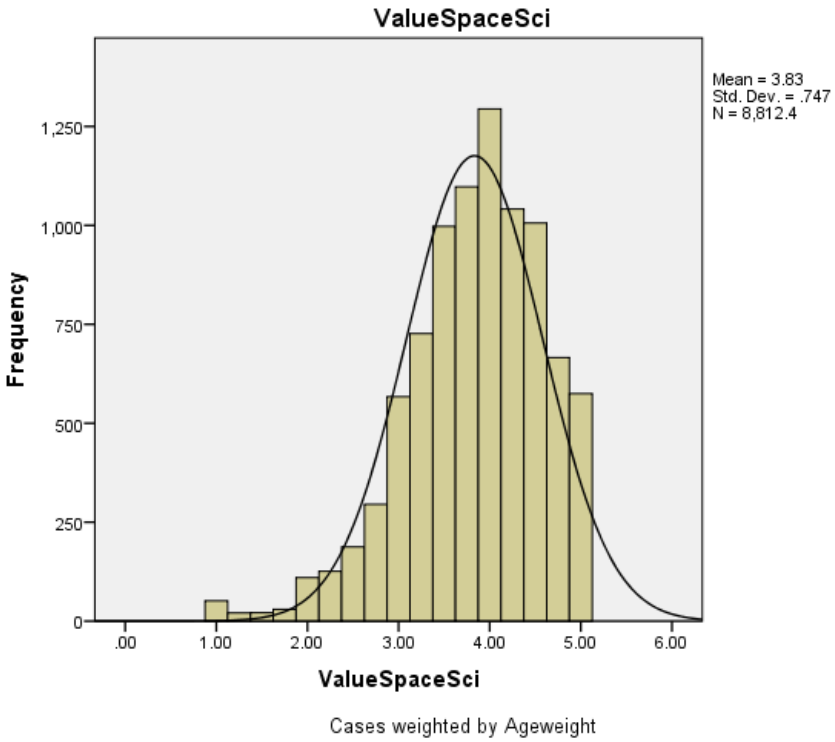

Figure 3.5 – Distribution of means for 'Valuing space science'

3.6.2 Differences by gender for the composite 'Valuing space science'

Gender	N	Mean	SD
Male	4252	3.8404	.78307
Female	4503	3.8284	.71091
Total	**8754**	**3.8342**	**.74681**

Table 3.47 – Summary of differences by gender for the composite variable 'Valuing space science'

Males and females did not differ significantly on this variable (p = .453).

3.6.3 Differences by age for the composite 'Valuing space science'

Age	N	Mean	SD
9 - 10	873	3.9168	.73670
11	1760	3.8061	.74844
12	1763	3.8528	.70998
13	1764	3.7973	.75789
14	1763	3.8137	.75138
15 - 16	890	3.8791	.78995
Total	**8812**	**3.8335**	**.74735**

Table 3.48 – Summary of differences by age for the composite variable 'Valuing space science'

There was a significant difference on this variable among age groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.885	5	2.577	4.623	.000
Within Groups	4908.610	8806	.557		
Total	**4921.495**	**8811**			

Table 3.49 – One-way ANOVA (Age) for the composite variable 'Valuing space science'

Age (years)	9 - 10	11	12	13	14	15 - 16
9 - 10		*	*	*	X	X
11			X	X	X	X
12				X	X	X
13					X	X
14						X

Table 3.50 - Indications of pairwise significant differences by age for the composite variable 'Valuing space science' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[27]

The mean of 9-10 year olds on this variable was significantly higher than that of 11, 12 and 13 year olds.

[27] Please refer to Table 3.48 for the direction of the differences.

3.6.4 Differences by country for the composite 'Valuing space science'

Country	N	Mean	SD
Bulgaria	625	3.9484	.69722
Czech Rep	708	3.7376	.74565
France	1196	3.9092	.74961
Germany	569	3.7494	.77297
Greece	699	3.7623	.72571
Italy	566	3.6363	.65450
Poland	763	3.7633	.84833
Portugal	748	4.0960	.65023
Romania	638	4.0568	.65610
UK & Ireland	943	3.6220	.76863
Spain	496	3.9296	.65979
Total	**7952**	**3.8358**	**.74501**

Table 3.51 – Summary of differences by country for the composite variable 'Valuing space science'

There was a significant difference on this variable among country groups. (See table below.)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	185.052	10	18.505	34.755	.000
Within Groups	4228.169	7941	.532		
Total	**4413.221**	**7951**			

Table 3.52 – One-way ANOVA (Country) for the composite variable 'Valuing space science'

Country	Bulgaria	Czech Rep	France	Germany	Greece	Italy	Poland	Portugal	Romania	UK & Ireland	Spain
Bulgaria		*	X	*	*	*	*	*	X	*	X
Czech Rep			*	X	X	X	X	*	*	X	*
France				*	*	*	*	*	*	*	X
Germany					*	X	X	*	*	*	*
Greece						X	X	*	*	*	*
Italy							X	*	*	X	*
Poland								*	*	*	*
Portugal									X	*	*
Romania										*	X
UK & Ireland											*

Table 3.53 - Indications of pairwise significant differences by country for the composite variable 'Valuing space science' (Calculated using Bonferroni post-hoc comparisons; * indicate differences between those pairs were significant; X indicates pairs were NOT significantly different)[28]

The most salient difference here is that the mean score of students in Portugal was significantly higher than each other country except Romania, suggesting high valuing of space science amongst Portuguese students compared with their international peers.

3.6.5 Regression for the composite 'Valuing space science'

Table 3.54 shows the regression model for the composite variable 'Valuing space science'. That is, it shows which variables are most closely related to this dependent variable.[29]

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	1.017	.046	
Age 9-11 [Ref: Age 15-16]	-.088	.023	-.054
Age 12-14 [Ref: Age 15-16]	-.070	.021	-.046
Interest in space-related activities	.103	.009	.144
Space science and my future	.163	.010	.206
Positive attitudes to space science	.140	.011	.172
Perceptions of work in space science	.378	.012	.314

Table 3.54 – Effects of background and composite variables on 'Valuing space science'

[28] Please refer to Table 3.51 for the direction of the differences.

[29] Only variables significantly related to the DV are included in the table.

The adjusted R^2 for this model is .447, indicating that 44.7% of the variance in the outcome variable is accounted for by the variables listed in the first column in Table 3.54. The beta weights indicate that 'Perceptions of work in space science' (composite) is most closely related to this dependent variable (Valuing space science), followed by composite variables 'Space science and my future', 'Positive attitudes to space science' and 'Interest in space science' activities. In addition, being in the younger two age groups is negatively related to scores on this dependent variable, possibly indicative of the way in which the means decrease and then rise again (see Table 3.48).

Next, a second regression analysis was conducted which used the smaller dataset (data from students in the countries with sufficient numbers of responses), which also included the country background variable. The results of that analysis are presented in Table 3.55.

	Coefficient (B)	SE	Beta (std)
Intercept (constant)	.834	.053	
Bulgaria	.191	.029	.067
Germany	.015	.029	.037
Greece	-.067	.027	-.025
Italy	-.180	.029	-.061
Poland	.181	.026	.073
Portugal	.282	.026	.112
Romania	.076	.028	.028
Spain	.083	.030	.028
Interest in space-related activities	.081	.010	.113
Space science and my future	.162	.010	.204
Positive attitudes to space science	.153	.011	.187
Perceptions of work in space science	.405	.013	.335

Table 3.55 – Effects of background (including country) and composite variables on 'Valuing space science'

The adjusted R^2 for this model is .468, indicating that 46.8% of the variance in the outcome variable is accounted for by the variables listed in the first column of Table 3.55. In this model, the beta weights indicate that 'Perceptions of work in space science' (another composite variable) is the variable most closely related to 'Valuing space science', and this is followed by the other three composites in the model, 'Space science and my future', 'Positive attitudes to space science' and 'Interest in space-related activities'. However, once the country variables were included, the age-related variables were not sufficiently related to remain in the model. Finally, most country variables were sufficiently closely related to the dependent variable to be included in the model. In particular, variables for Bulgaria, Germany, Poland, Portugal, Romania and Spain were positively related to 'Valuing space science', while variables for Greece and Italy were negatively related. Recall, however, that this is relative to the reference category of France, and controlling for other variables. In addition, the mean for this variable overall is fairly high, suggesting that, across the sample, students value space science and consider it to be important as a field.

4. Appendices

The following documents (English versions only) have been included as online appendices:

4.1 Copy of the pupil survey

4.2 Instructions to nodes regarding survey distribution

4.3 Information sheet for teachers

4.4 Information sheet for parents/guardians

In compiling this report we wish to acknowledge the very important contributions of the various partners and nodes who managed the data collection processes at local level, as well as the teachers who willingly managed their pupils' involvement, and of course the pupils themselves. Your efforts have been a tremendous help in providing this view of European pupils' perspectives on space science, and offer a valuable contribution to space science teaching throughout Europe and beyond. Thank you.

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