SPACE awareness

Deliverable 7.1
Evaluation Framework

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Publishable summary

The aim of this deliverable is to present the progress to date regarding the development of the Evaluation Framework for the European Space Awareness (EUSPACE-AWE) project. Professional evaluation is embedded throughout the Space Awareness activities in order to:

- Determine a baseline of student attitudes, as well as identifiable influences on those who have gone on to pursue careers in space science.
- Provide formative evaluation to assist in refining and improving the project activities.
- Provide robust and consistent summative data across key project activities in order to determine the overall impact of the programme.

Such efforts will help to create a sustainable legacy for Space Awareness that will long outlive the duration of the project. It is worth noting that this Deliverable is a “live” document in that many of the processes and contents described will undergo refinement during the course of their implementation in the remainder of the Space Awareness project.

Section 1 provides a brief introduction to the Space Awareness project generally, as well as the Evaluation Framework more specifically.

Section 2 outlines the Space Awareness Generic Outcomes: a set of intended impacts for the programme that have been developed and agreed across the consortium. These outcomes are fundamental to the subsequent baseline research and evaluation efforts.

Section 3 details the ethical considerations and formal approval processes that have been taken into account within the project, most notably informed consent; confidentiality and data storage procedures. Of particular interest for Space Awareness is obtaining consent to follow up with participants at a later date (1-3 years after their involvement) to explore more longitudinal impacts.

Section 4 comprises a schedule outlining the remaining tasks and responsibilities within the evaluation workpackage. Further detail on each of these tasks is presented in sections 5&6.

Section 5 presents details of the efforts within the evaluation workpackage relating to determining baseline attitudes towards space science across Europe. This research will not only provide unique insights at European level, but it will also allow direct identification of likely impacts that occur as a result of the Space Awareness activities. There are two main components that are described: firstly, a survey of school students aged 10-15 which was distributed in 13 languages, with a target of 500 responses per participating country. Secondly, a retrospective survey of current space scientists, coupled with interviews recorded with identified ‘role models’ across Europe, which will provide insights into influences on the career choices of individuals working in space science. Details regarding the current status and remaining efforts relating to both elements are provided here.

Section 6 consists of a series of tools and protocols that are explicitly designed to assist in evaluating the Space Awareness programme. The Evaluation toolkit provides a coherent and consistent set of tools and instructions to enable robust evaluation of the main project activities as they are implemented by nodes and networks across Europe and internationally. Rather than focusing in detail on specific activities, the evaluation toolkit is framed around the agreed Space Awareness Generic Outcomes in order to enable greater comparability and robustness in the data collected. Specific sub-sections focus on the educational resources; face-to-face teacher training; MOOCs (Massive Open Online Courses) and online components.

A list of supporting annexes is provided in section 7. For brevity these supporting annexes are provided online.

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1. Introduction

Professional evaluation ensures that the project resources and activities are relevant and applicable to the various target audiences. This will help create a sustainable legacy for Space Awareness that will long outlive the duration of the project. In particular there are three main areas of focus:

- Audience pre-research and investigation of decision making relating to space and technical career choices will enable a baseline of existing attitudes to be determined.
- Formative evaluation and piloting of materials will allow improvement.
- Summative evaluation will provide clear indications regarding overall impact.

All evaluation procedures are conducted according to appropriate ethical guidelines, and with an emphasis on developing and maintaining suitable networks and contacts in order to be able to conduct longitudinal assessments of the impacts of the Space Awareness programme in the future.

This document outlines the main features[1] of the Evaluation Framework to date. It should be noted that this is a 'living' document, undergoing constant revision and improvement as the various tools are implemented and feedback is received.

1.1. Project Background

A brief overview of the Space Awareness project is provided here in order to provide context for the Evaluation Framework. For further information about the project see www.space-awareness.org.

Project Aims

1. To help stimulate the next generation of European space-oriented engineers and scientists, particularly girls and ethnic minorities.
2. To use the perspective of space and the Universe to broaden children's minds, develop a sense of European and global citizenship and foster tolerance for diverse culture.
3. To help build the scientific and technological capacity of developing countries, particularly in Africa.

Particular attention is on girls, ethnic minorities and those from disadvantaged communities. Note that for the purposes of the Evaluation Framework emphasis has been placed on school-aged students and school teachers (both primary and secondary level, and potentially including other outreach educators), as this is where the bulk of the activity development and effort within the project is focused. This target audience is of paramount importance to the fulfillment of the project goals since recent research suggests that teachers and the relationship that the young have with school science is a key factor in the choice of scientific careers in the future (Tytler & Osborne, 2012; Regan & DeWitt, 2015).

[1] Where appropriate necessary terms have been introduced and defined, however for brevity a basic understanding of evaluation processes has been assumed. For further information and background on evaluation refer to the RAEng Evaluation Toolkit and RCUK Evaluation: Practical Guidelines, as well as the excellent Principal Investigator's Guide for a more detailed perspective.

1.2. Purpose and scope of the Evaluation Framework

Evaluation Aims

There are four key aims in relation to the Evaluation Framework described within this Deliverable:

1. Formative evaluation to shape the project's activities to ensure that they will meet the aims of the project and the audiences' needs, with a spirit of continuous improvement.

2. To report and measure the impact of the project in a way that is consistent across all activities and pays particular attention to any differences associated with intended career choice, gender, ethnicity and socio-economic status.

3. To provide evidence of the project's successes and areas for improvement and help communicate these findings to policymakers, funders and others working in science education and engagement.

4. To establish a baseline dataset regarding existing attitudes and opinions towards space science, as well as developing an approach for determining longitudinal impacts of the programme.

Determining Impact

In relation to the aims above, the Space Awareness evaluation includes consideration of three key elements:

- **Reach**: the number and diversity of participants engaged in the project activities (with special attention to girls, ethnic minorities, and disadvantaged communities).

- **Significance**: the changes (resultant "outcomes" of the project activities) that occur in both the short-term and the long-term.

- **Process**: learning about how/why the audiences use resources to inform future activity.

Monitoring *reach* and *process* are fairly self-explanatory, however *significance* requires further delineation as outlined in Section 2 below.

2. Space Awareness Generic Outcomes

Generic Outcomes

In order to clarify our analysis of 'significance' we have drawn on the project aims to set more specific outcomes that we can evaluate effectively. These generic outcomes are designed to cut across all the various activities within Space Awareness to provide a coherent and comparable set of indicators. Building on the identified outcomes of the FP7-funded UN-AWE project, these outcomes have evolved to reflect the updated aims of influencing career choice. We have chosen the widely-used Generic Learning Outcomes framework as a starting point due to its wide applicability and high relevance to the Space Awareness project's goals. Our Generic Outcomes focus on the benefits that the project participants gain from participating in the various Space Awareness activities.

Generic Learning Outcomes
www.artscouncil.org.uk/measuring-outcomes/generic-learning-outcomes

Final agreed Space Awareness Generic Outcomes

The project-wide Generic Outcomes shown on the following page were developed by the evaluation leads (UCL) in close consultation with the wider Space Awareness consortium via a multiple-stage iterative process of revision and feedback. They deliberately draw on the overarching project aims as well as the main target audiences mentioned in Section 1.1. For brevity a single-page version is provided here; a slightly more detailed version is also available in Annexe A.

Note that for the purposes of this framework, 'participants' refers to the people using Space Awareness resources, which could include teachers and other educators, school-aged students, and members of the public. Additionally, not all outcomes are appropriate to all participants or all resources; a map of which resources type target which outcomes is provided in Section 6.1; further detail on the face-to-face workshops is outlined in Annexe H1.

As a result of Space Awareness, participants will:

Feel* *Enjoyment, inspiration and creativity*	**Value*** *Attitudes & values*	**Do** *Action, behaviour and progression*	**Understand** *Knowledge and understanding*	**Skills** *Skills*
Activities are interesting **Enjoy learning about space** **Inspired by space science** **Positive** about space science (and careers)	Diverse contributions from **different cultures** to space science Contributions made by both **women and men** European and Global **citizenship** The contribution space science makes to **everyday life** That **school science is relevant** to current space science *Also:* People working in space science are '**real people**'	Access and use Space Awareness activities **confidently** **Want to learn more** about space science Consider choosing, or encourage others to choose, to study and pursue **careers** in space or science and engineering # *Also:* **Share** their understanding of space science with others	Highlights of **space science** content (3 themes) Space science can be used for **teaching many disciplines** (cross-disciplines and non-science subjects) Space science **careers** are diverse, rewarding and highly accessible # Space science needs an **interdisciplinary approach** Space science is an **international endeavour** *Also:* Career opportunities at **all levels** **Relevant pathways** to careers Space science relies on the **scientific method**	Carry out **scientific or technical activities** themselves Develop **inquiry-based skills** for teaching/learning about space science Learn how to use **IT** to teach/learn about space science Learn how to be **more inclusive** when teaching *Also:* Develop skills used by space scientists

Notes

- Key priority outcome categories are marked *
- 'Also' refers to aspects that were agreed to be slightly lower priority than the others listed here
- Shaded areas refer to teacher-specific outcomes
- Outcomes with a particular focus on girls, ethnic minorities and/or disadvantaged backgrounds are marked #
- 'Science' is intended to be very inclusive, incorporating technology, engineering, mathematics etc.

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3. Ethical Considerations

All elements of the Space Awareness evaluation follow appropriate ethical guidelines, in particular:

- **Informed consent** – All participants must be fully informed of their involvement in the evaluation and what is being asked of them, including whether their data will be used in future for tracking purposes. The decision to participate must be an active step on behalf of the participant and not due to any inducement, coercion or perceived pressure to participate.

- **Confidentiality** – All participants have the right for their participation to remain confidential in that only the activity organizer and the evaluation team will be aware who has participated. Generally all data will be reported anonymously (e.g. in reports or publications) so that nothing can be attributed back to an individual participant.

- **Under 16s** – Parental and/or guardian consent must be sought for any identifiable participants aged under 16 at the time of their involvement in an activity.

- **Data storage** – Any personal data (contact details, opinions, test results etc.) will be handled sensitively and in a protected format e.g. on password-protected encrypted computers.

NOTE: Of particular interest for Space Awareness is obtaining consent to follow up with participants at a later date (1-3 years after their involvement) to explore more longitudinal impacts. Though much of this follow up will be outside the scope of the Space Awareness project, we are setting up the appropriate processes and permissions to be able to incorporate such follow-up in potential later projects. Of course explicit consent must be sought for longer-term storage of personal details such as contact information; refer to Annexe C for details regarding an appropriate information sheet and consent form to this purpose.

Ethical Approvals

As the lead evaluation partner UCL has sought official ethical approval for the project processes via UCL's Research Ethics Committee. This has included setting up appropriate ethical mechanisms across the project, in consultation with project partners and nodes. Partners and dissemination nodes are responsible for abiding by such processes and ensuring that all personal data is handled sensitively and stored in an appropriate way. To date ethical approvals have been granted for three separate populations (copies of the appropriate documentation are available in Annexes B1, B2, B3 and B4):

- School students – UCL Ethics Project ID Number: 4241/003, approved 15/10/15

- School teachers – STS Ethics Project ID Number: STSEth074, approved 4/9/15

- Current space scientists – STS Ethics Project ID Number: STSEth075, approved 4/9/15

4. Evaluation work schedule

The table on the following page describes the intended schedule for the remaining evaluation effort within the Space Awareness project. Details of the current status and intended effort for each element are discussed further in sections 5 and 6. Note that these timings are approximate and funadamentally rely upon when the various resources and activities are finalised and implemented.

Further information on the actual activities and resources to be evaluated is provided in various existing project deliverables; links have been provided to these Deliverable reports where appropriate.

Task description	Lead	Project Month (M18 = August 2016)																	
		19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Baseline attitudes towards Space Science across Europe																			
Student survey																			
Final data collection (online)	UCL																		
Survey analysis and country-level feedback	UCL																		
Reporting results of pupil survey	UCL																		
Retrospective survey and role model interviews with current space scientists																			
Final survey data collection (online)	UCL																		
Interview recording (ongoing intermittently)	OU																		
Analysis	UCL																		
Reporting	UCL																		
Evaluation Toolkit																			
Educational Resources D2.1 D3.1 D4.1																			
Finalisation and distribution of resources	EUN, UL, HdA																		
Distribution of evaluation instructions to nodes	EUN, UCL																		
Piloting and refinement of evaluation protocol	Nodes, UCL																		
Evaluation data collection	Nodes																		
Analysis & reporting	UCL																		
Face-to-face teacher training courses D2.1																			
Finalisation and distribution of guidelines	UL, UCL																		
Workshops delivered locally	Nodes																		
Evaluation data collection	Nodes																		
Analysis & reporting	UCL																		
MOOCs D2.1 D2.2																			
MOOC1 delivery	EUN etc.																		
MOOC1 evaluation data collection	EUN																		
Refinement of MOOCs content & approach	EUN etc.																		
MOOC2, MOOC3, MOOC4 delivery	EUN etc.																		
Evaluation data collection	EUN																		
Analysis & reporting	UCL																		
Citizen Science activities D3.2																			
Finalisation of online questionnaire	UCL, UL																		
Evaluation data collection	UL																		
Analysis & reporting	UCL																		
Online components D5.1																			
Web analytics (ongoing)	UL																		
Development of responsive online tools	UCL, UL																		
Implementation of responsive online tools	UCL, UL																		
Development of social media protocols	UCL, EUN																		
Social media evaluation data collection	UCL, EUN																		
Analysis & reporting	UCL																		
Aggregation of impacts analysis	UCL																		
Final reporting	UCL																		

5. Baseline attitudes towards Space Science across Europe

5.1. Purpose & scope

One of the main objectives for the Space Awareness project is to stimulate interest in space science careers, with the ultimate aim of increasing the number of young people choosing to enter careers related to space science. In order to gauge effectiveness of activities in the project in stimulating interest in and positive attitudes towards space science, it is important to have a baseline measure against which any progress can be judged. In addition, such a baseline would provide important information about current attitudes towards space science held by young people across Europe, which could be useful in informing project activity. While there have been multiple surveys measuring attitudes towards science generally, both internationally (e.g. the Programme for International Student Assessment, PISA; Relevance of Science Education, ROSE) and within individual European countries (e.g. ASPIRES in the UK), very little is known about attitudes towards space science in particular.

While one of the aims of the project is to encourage more young people to pursue space science careers, the three-year timeframe of the project limits the possibility of investigating the impact of project activities on actual career choice. That is, the time span between when pupils might participate in project activities and when they begin work is considerably longer than the three years of the project. Thus, we are limited as to how much we can find out about the impact of project activities. As a way of addressing this limitation, we also set out to explore influences on the career choices and paths of individuals currently working in space science. By finding out more about the paths individuals took into space science and what key influences were along the way, we should be able to identify areas in which project activities may be able to impact career choices and decisions.

In response to these limitations, the evaluation incorporates two kinds of baseline measures – a survey of student attitudes towards space science and a survey of adults[2] working in space science careers. We envisage the Space Awareness project activities as linking these two ends of the timeline – where European students are currently (the student survey) and where we hope many will be in time (the adult survey). Additionally, to provide further information about why and how individuals pursue space science as a career, qualitative interview data has been collected from a smaller number of adults, which should provide richness and additional insight into the adult survey data.

In summary, the pupil survey will provide a baseline of attitudes and motivations towards space science to inform activity within the Space Awareness programme, which should help gauge the success of the project over time and inform future initiatives. The adult career choice survey and qualitative interviews will provide a retrospective view on what has influenced space scientists' career choice, thereby again informing the development of resources and content within the project.

[2] N.B. the adult survey also includes post-secondary students – university or graduate level, who are on the path to pursuing careers in space science.

5.2. Student survey

A student survey has been developed in order to gauge attitudes towards space science among young people in Europe. The results will form a baseline against which later data, either collected following participation in Space Awareness activities or via future surveys, can be compared. The focus of the survey is on areas that previous research suggests are most likely to be influenced by participation in Space Awareness activities. The survey items also map onto the agreed project outcomes. For the sake of brevity (which is critical to completion rates), areas that would be interesting or 'nice to know' were eliminated.

Student survey development

In developing the survey, we drew on previous research around attitudes to science, looking particularly at any work on attitudes to space science (which was limited). Key international surveys which informed the development of the survey included PISA (particularly PISA 2006, which focused on science), TIMSS, and relevant Eurobarometer work (most notably Flash Eurobarometer 239; Special Eurobarometer 340; Flash Eurobarometer 272; Special Eurobarometer 403; and Flash Eurobarometer 355. The ROSE (Relevance of Science Education) survey was also particularly relevant as it included several items concerning interest in space science.

In addition to the surveys mentioned above, the student survey also drew on two major pieces of longitudinal work around attitudes and aspirations in STEM: the ASPIRES project and the Enterprising Science project, both based at King's College London. The surveys used in these projects cover a range of topics relevant to attitudes and aspirations in science, though not space science in particular. The surveys used in these projects draw heavily on previous research. They have been carefully developed and thoroughly tested, as have many of the instruments on which they draw.

Student survey content

Overall, the survey contains eleven questions, four of which collect background information (e.g. age, country). The remaining questions contain a total of 34 items, covering a range of topics related to attitudes toward space science (and connected to the agreed project generic outcomes outlined in Section 2). More specifically, these topics include: aspirations for future study and/or work in space science, valuing of space science (e.g. for its contribution to society), understanding of space science as a field (e.g. that a range of jobs are involved, that discoveries are made by individuals from a range of backgrounds), awareness of paths to space science careers, perceptions of jobs in space science and of those who work in the field, interest in space science, participation in activities related to space science (in and outside of school). These areas not only map on to project outcomes but, importantly, are areas that previous research (e.g. Aschbacher, Li, & Roth, 2010; DeWitt, Archer, & Osborne, 2014; Sjaastad, 2012) suggests are key components in individuals' decisions related to study and work. Thus, these are important areas which Space Awareness activities should aim to influence in the attempt to encourage more young people to consider careers in space science. For further detail see Annexe D3, plus annexes D1, D2 and D4 for various supporting materials.

Student survey logistics

The student survey is online, using the Opinio software hosted at UCL. It is available in 13 languages (Bulgarian, Czech, Dutch, English, French, German, Greek, Italian, Norwegian, Polish, Portuguese, Romanian and Spanish). The survey has been translated from English by partners and nodes in the project, and has been distributed by the nodes to schools in their respective countries (Bulgaria, Czech Republic, Netherlands, UK, France, Germany, Greece, Italy, Norway, Poland, Portugal, Romania Spain). This involvement in data collection is part of the evaluation activity that the nodes (and partners) are expected to support. The survey aims to target students in late primary and early secondary school, and thus the age range for the survey is 10-15. We aimed to have 500 students per country complete the survey, distributed evenly across the target ages.

The nodes and partners were recommended to involve participating students from at least two different schools in order to achieve a slightly more representative perspective. They were also advised to recruit schools that serve a range of pupils (i.e. are neither targeting exceptional students only, nor in overly deprived areas). Finally, ideally the schools involved would be ones likely to use the Space Awareness activities. However, due to resource limitations, considerable flexibility was necessary.

Nodes and partners were provided with information for teachers/schools and for parents, the latter also included an opt-out consent form. (Because the data collected was anonymously, parental opt-in was not required.)

Student survey responses to date

The survey launched in February 2016, with the majority of data being collected in April – June 2016. To date, the survey has been completed by 5870 students: 535 ages 9-10; 762 age 11; 870 age 12; 992 age 13; 920 age 14; and 1793 ages 15-16. A few countries have reached their target numbers (500, spread across the target age range), while others still need more responses from particular ages, and a very small number have only been able to gather limited data thus far. Consequently, the survey will be open again during autumn 2016 and nodes will be supported to reach their targets.

To date, preliminary reports have been sent to individual partners/nodes (summarising responses thus far). Following the remaining data collection, more in-depth analysis will be conducted in early 2017, exploring patterns by country, age and gender, as well as drawing out implications for project activity.

5.3. Retrospective survey of current Space Scientists

This second survey was developed with the purpose of exploring influences on the career choices of individuals working in space science (with a secondary target of university or postgraduate students who are studying in this field). While we do not have data on attitudes, interests, experiences and choices of space scientists gathered when they were younger, by exploring areas we know may be linked to their choices and career paths, the survey (as well as the interviews described in Section 5.4) give us the opportunity to better understand the influences of various activities, experiences and individuals on their choices. While such information has been gathered from a range of scientists in previous work (e.g. Maltese & Tai, 2010; 2011), little of this work to date has specifically focused on space scientists.

Retrospective survey development

In developing the survey, we drew on the IRIS (Interests and Recruitment in Science) project (which focused on European students studying STEM subjects at university) and, especially, work by Adam Maltese (Project Crossover, as well as subsequent studies, both interview and survey, with thousands of scientists and science students in physics and chemistry, particularly in the US and China), as well as that of Grady Venville (survey work with scientists, many in Australia and New Zealand). Adam Maltese in particular is well-known internationally for his research on the sources and development of interests in scientists and the influences on their career-related choices. For further detail regarding the retrospective survey see Annexes E1 and E2.

Retrospective survey content

In addition to background/demographic questions (e.g. age, sex, nationality and whether they are working or studying), the survey included questions about sources of initial interest in space science (e.g. people, school, out-of-school experiences) and maintenance of that interest. The survey also specifically seeks to identify whether interest in space science developed initially or whether it emerged from a broader interest in science. Questions are included relating to parental support for interests in space science and the survey specifically investigates the development of career aspirations in science and space science. Further questions ask about career path, as well as barriers encountered along the way.

Retrospective survey logistics

Recruiting participants for such a survey is inevitably challenging (previous research[3] has achieved a response rate of around 8-10% at best). Consequently, the survey has been distributed using a range of routes, primarily via promotion at relevant conferences and seminars (e.g. EPSC, International Venus Conference, Europlanet workshops), as well as via newsletters and listservs (e.g. Eurospace). Personal contacts and networks (e.g. in the Austrian space industry or working in a Belgian university) have also been utilised.

Retrospective survey responses to date

The survey has been completed by at least 360 individuals, which provides a good sample for analysis. The survey will remain open until data analysis begins in September 2016. Refer to the work schedule in section 4 for further information about the timing and focus of the remaining tasks in this survey.

5.4. Role model interviews

In addition to the survey of individuals working or studying in space science described in Section 5.3, we have also had the opportunity to collect further qualitative data from a subset of this population. In particular, as part of the creation of careers resources (WP 6: Career aspirations), individuals working/studying in space science are being interviewed for the purposes of creating role model videos which will be accessible via the Space Awareness

[3] This information has been sourced through personal conversations with the researchers involved.

website. The evaluation team have had the opportunity to feed into these interviews and have recommended the inclusion of questions related to the following topic areas, which align with the questions in the retrospective space scientist survey (described above):

- Sources of interest in (space) science
  - People (family, mentors, friends, teachers)
  - Out of school experiences
  - School experiences
- Pursuit of interest in (space) science – in and outside of school
- Support for interest
- Barriers to pursuit of interest
- Family influences (interest in science)
- Experiences of science at school and university
- Path to current job – choices made and reasons for choices (motivations)
- Whether individuals were initially interested in science broadly and then became interested in space science in particular, or whether it was space science that initially attracted their attention

To the extent that it has been possible to incorporate these questions into the interviews (it has not been possible in all interviews conducted to date, due to time restrictions), this qualitative data will provide valuable insight into the paths that have led individuals into space science. Such information will be useful in illustrating and enhancing the findings emerging from the space scientist survey.

To date, 18 interviews have been conducted with individuals in a range of posts, including students. There are 11 women and 7 men, from countries both within and outside of Europe. While some of the interviews were quite short, all participants are willing to be contacted at a later date to provide further information, should that prove helpful. See Annexe F2 for a copy of the interview schedule, and Annexe F1 for the associated ethical forms. Additionally, Annexe F3 contains a list of interviewees to date, as well as basic background information on each person.

6. Evaluation Toolkit

6.1. Purpose & scope

The Space Awareness evaluation toolkit is comprised of the main protocols and evaluation tools that have been developed to investigate the impacts of the programme overall. As noted in Section 1.1, particular attention has been paid to delineating the results according to gender, ethnic and socioeconomic background (where possible). Additionally, emphasis has been placed on school-aged students and teachers (both primary and secondary).

The evaluation toolkit provides a coherent and consistent set of tools and instructions to enable robust evaluation of the main project activities as they are implemented by nodes and networks across Europe and internationally. Feedback has been sought during their development in order to ensure that they are user-friendly and feasible to implement at local level, and an upcoming piloting phase (see timeline for details) will provide further input and refinement. Rather than focusing in detail on specific activities, the evaluation toolkit is framed around the agreed Space Awareness Generic Outcomes in order to enable greater comparability and robustness in the data collected.

Data collection

Local level data will be collected by the network of nodes associated with Space Awareness (23 institutions across Europe and internationally) and fed back to the central evaluation team at UCL for analysis. This feedback covers both formative and summative elements; including particular successes, how the resources could be improved and what impacts resulted from their use. Where possible (and especially in relation to the teacher training elements), chronological triangulation has been incorporated in order to determine both immediate and longer term impacts on the participants, including collection of baseline information where possible.

Translation

In line with the policy on translating the educational resources themselves, partner nodes may optionally select to translate the evaluation materials into their local language(s). To facilitate such translation, and to minimise translation/comprehension errors, the evaluation materials have been reviewed by representatives from multiple different language backgrounds for both sense and clarity.

Data analysis

The data collected by the nodes (and online via the Space Awareness website, see Section 6.7) will be aggregated and synthesised by the lead evaluation partner, UCL. Quantitative data will be analysed statistically (where appropriate according to the sample size involved) using SPSS to identify key trends and correlations. Qualitative data will be coded using nVivo to determine common themes, and also mined for valuable quotes and anecdotes to be used for reporting and dissemination purposes.

Reporting at node level will enable international comparisons of local results, whilst the aggregated data will determine the overall impacts of the programme. Patterns and trends will be explored in depth in order to inform future developments within space outreach efforts and beyond into other relevant fields.

6.2. Map of agreed Generic Outcomes to Space Awareness project resources

As described in Section 2, a set of intended Generic Outcomes have been agreed for the Space Awareness project as a whole. However, different resources prioritise different outcomes. It is also useful to consider the Generic Outcomes from the different perspectives of *students* and *educators*. The following table provides an indication as to which outcomes are intended by each of the main Space Awareness project resources considered within this Deliverable, divided into educators (E) and school-aged students (S).

Space Awareness Generic Outcomes	**Space Awareness Project Resources for educators and students**						
	Primary Education resources	Secondary Education resources	Face-to-face training workshops	Teacher MOOCs	Citizen Science projects	Space Scoop	Space Careers Advice/ Career hub
Priority outcomes are listed below; *Grey writing indicates additional outcomes of slightly lower importance* ***'E' indicates that outcome is relevant to Educators; 'S' means school-age students***							
Feel ***Enjoyment, inspiration and creativity*** **= MAJOR PRIORITY CATEGORY**							
Find Space Awareness activities interesting	ES	ES	ES	ES	ES	ES	ES
Enjoy learning about space	ES	ES	ES	ES	ES	ES	ES
Feel inspired by space science	ES	ES	ES	ES	ES	ES	ES
Feel positive about space science	ES	ES	ES	ES	ES	ES	ES
Aspire to space science careers	S	S			S	S	S
Value ***Values and attitudes*** **= MAJOR PRIORITY CATEGORY**							
Value the diverse contributions of many different cultures to space science	S	S	ES	E		E	ES
Value the contributions made by both women and men to space science	ES	ES	ES	E		E	ES
Value trans-national European and Global citizenship	ES	ES	ES	E		E	ES
Appreciate that space science contributes to everyday life	ES	ES	ES	E	ES	E	S
Appreciate that school science is relevant to space science	ES	ES	ES	ES			
Appreciate that people who work in space science are real people			ES	E		E	ES

Space Awareness Generic Outcomes	Space Awareness Project Resources for educators and students						
	Primary Education resources	Secondary Education resources	Face-to-face training workshops	Teacher MOOCs	Citizen Science projects	Space Scoop	Space Careers Advice/ Career hub
Priority outcomes are listed below; ***Grey writing indicates additional outcomes of slightly lower importance*** ***'E' indicates that outcome is relevant to Educators; 'S' means school-age students***							
Understand ***Knowledge and understanding***							
Highlights of space science (Our Wonderful Universe, Our Fragile Planet and Navigation through the Ages)	ES	ES	ES	ES		ES	
Space science can be used for teaching in many disciplines including cross-disciplinary contexts and non-science subjects	E	E	ES	ES	E	E	
Understand space science career opportunities are diverse, rewarding and highly accessible (particularly to girls and ethnic minorities)			ES				ES
Space science needs an interdisciplinary approach	ES	ES	ES	ES			ES
Space science is a global/European endeavour			ES	E	ES		ES
Career opportunities in space science and technology at all levels			S	ES			ES
Relevant pathways to these career opportunities			S	S			ES
Space science is not a fixed body of facts or topics but a process that builds on contributions made by scientists over time		E	ES	ES	ES	ES	
New discoveries are being made continuously through scientific inquiry and sometimes disprove previous theories		E	ES	ES	ES	ES	S
Do ***Action, behaviour and progression***							
Access and use Space Awareness activities confidently	E	E	ES	ES	ES		
Want to learn more about space science	ES	ES	E	E	ES	ES	ES
Choose or consider choosing, or encourage others, to study and pursue careers in space science and engineering or science and engineering more widely, especially girls and ethnic minorities	ES	ES	ES	ES	ES	ES	ES
Share their understanding of space science and technology with learners, peers, family and/or their community	ES	ES	ES	ES	ES	ES	ES
Skills							
Learn how to carry out scientific or technical activities themselves	ES	ES	ES	ES	ES		
Develop inquiry-base skills for teaching/learning about space science	ES	ES	ES	ES			
Learn how to use IT to teach/learn about space science	ES	ES	ES	ES	ES		
Learn how to be more inclusive while teaching, particularly for girls and minorities	E	E	ES	ES			
Develop skills used by space scientists	ES	ES	ES	ES	ES		

6.3. Educational resources: evaluation protocol

There are currently 20 Primary and 80 Secondary education resources available through Space Awareness, broken into 3 key themes: Our Wonderful World; Navigation through the Ages; and Our Fragile Planet. In addition, there is a separate kit focusing specifically on the contributions of Islamic Science to space science. (The full listing is currently under development within workpackages 3 and 4). These activities are all designed to be run by teachers in their own classrooms, with the necessary resources and information provided online via the project website. In addition to Europe-wide distribution via key project partners and the project website, each project node is responsible for disseminating these resources within their own country.

To ensure comparability and robustness within the Space Awareness evaluation, a single evaluation protocol has been developed which is applicable to all of these educational resources. The protocol consists of three main aspects (see Annexes G1 and G2 for current versions of the first two documents in this list):

1) *Instructions to nodes* – details for each of the node partners outlining how best to collect teacher feedback. This document introduces the activities themselves, instructions on how to select resources for feedback (to ensure wide coverage regarding which resources are tested), and specific advice regarding the questionnaire itself.

2) *Resource feedback form* – This is the questionnaire that teachers are asked to complete. It contains brief sections about the teacher and the students they tried the activity with (for context); what (if any) other associations the teacher has had with the Space Awareness project (e.g. attending a training course or similar); the teacher's reactions to the activity; and how they felt their students reacted to it. The feedback form is strongly linked to the Space Awareness Generic Outcomes outlined in section 6.1 and as such should provide a clear indication as to whether the resources meet the intended objectives of the programme. For ease of completion and to assist with comparison across different language backgrounds the majority of questions are quantitative in nature, though space has been left for qualitative comments where appropriate. There are also qualitative sections asking teachers to highlight any particular 'wow' moments, or conversely, how the activity could have been improved.

3) *Reporting portal* – An online portal will be provided for nodes to enter the data gathered locally. Sections will be available for uploading of the questionnaire data, as well as more general comments/feedback (for example if they were able to observe a lesson directly, or if they received any comments or direct feedback from teachers separate to the questionnaire).

Node and teacher representatives from across Europe have been invited to feedback on the questionnaire, which has helped in refining its content and ensuring it is fit for purpose. The version provided in Annexe G2 is intended to be piloted as part of the initial dissemination of the resources themselves (beginning September 2016). Further refinements based on feedback and initial data collection will be incorporated, with the final version of the protocol implemented in winter 2016. Each node is expected to recruit 20 local teachers to test the various educational activities using the protocol, and feedback the results to the central evaluation team (UCL) for further analysis and synthesis of results overall by April 2017.

6.4. Face-to-face teacher training: evaluation protocol

Bespoke face-to-face teacher training workshops have been developed[4] as part of the Space Awareness project (including one optional extension element). These training sessions are designed for primary and secondary teachers from any discipline. Based on the partners' experience of successful similar training previously, the training sessions have been developed on the basis of a three-hour workshop, though they can be reduced, extended or combined as needed for longer and shorter workshops. Workshops include hands-on activities and theoretical sections. Each workshop is followed up by an activity to be implemented by the teacher/educator with children and an exchange with the workshop organiser on the implementation. All trainings can be complemented or combined with the use of the free online Space Awareness resources, including further online course materials.

The five training courses

- A: Space Awareness by topic:
  - A1 - Our Fragile Planet
  - A2 - Navigation through the Ages
  - A3 - Our Wonderful Universe
- A (additional option): developing ICT skills with space
- B: Introducing space sciences and careers in education
- C: Space for global citizenship

The intention is that pre- and post- workshop activities (such as an online needs and priorities analysis and a follow-up discussion between the workshop organiser and participating teachers) will assist to ensure that the workshop learning is embedded within the teachers' everyday practice. Additionally, each workshop has clearly defined (though different) learning objectives for participants, based on the Space Awareness Generic Outcomes outlined in Section 6.1. Annexe H1 provides a map regarding which workshops target which particular GO's. All of these elements have been taken into account when designing the face-to-face workshop evaluation protocols.

The face-to-face workshop evaluation element deliberately incorporates both temporal and participant triangulation; participants are asked to provide their views at different stages of their involvement, and inputs are sought from both the teachers themselves, as well as the workshop organisers. Wherever possible the evaluation approaches have been designed to tie in with existing activities associated with the workshops in order to simplify the processes involved and make the evaluation a meaningful reflective element of the workshops themselves.

Evaluation data for the face-to-face training workshops will thus be collected as follows:

1) *Research registration form*[5] (optional) – To be completed by both teachers and workshop organisers to potentially enable longitudinal follow-up.

[4] Nodes have also been offered the option to incorporate Space Awareness elements within their own existing space education training (Workshop D) rather than run a separate dedicated course. In this situation they would use the Educational Resources feedback protocol described in Section 6.3.
[5] See Annexe C for details.

2) *Workshop feedback form for teachers* – This hardcopy questionnaire will consist of two parts:
   - An initial component to be completed at the start of the workshop to provide a baseline indication of teacher experience and perspectives. Basic (anonymised) demographic information will assist in providing context for the teachers' subsequent responses.
   - A final component to be completed immediately at the end of the training course. This will incorporate both their reactions to the course itself as well as reflections on any changes to their own perspectives or likely future behaviours. Specific feedback regarding the course itself will include the opportunity to rate the course overall, which aspects they did or didn't enjoy, and what improvements they might suggest in future. Additionally, teachers will be asked to rate simple statements relating to the Space Awareness Generic Outcomes. These statements will help ascertain to what extent the teachers felt the workshop objectives were met. The statements differ depending on which workshop the teacher attended, however some of the wider statements will also be included in order to provide control indicators. This approach will enable robust comparison regarding whether different courses effectively achieved their stated objectives (e.g. did courses that focused on careers elements achieve higher 'agree' results than other courses with no careers component).

3) *Workshop feedback form for course organisers* – An electronic questionnaire will allow workshop organisers to feed back on the course itself from their perspective (covering similar aspects to the teachers' form described above). There will be opportunities to report back on how many teachers attended, (approximately) what their backgrounds were, and any specific successes or challenges they encountered. Workshop organisers will also be asked to indicate to what extent they felt their course met each of the Space Awareness Generic Outcomes. This element has been included in order to provide local insights into priorities and content, and to provide further context for the teachers' responses in this regard. This form will also capture any additional anecdotal comments or reflections from the teachers that may have arisen during the workshop. Workshop organisers will complete this element as soon as possible after the training.

4) *Follow-up feedback form for course organisers* – After the workshop the teachers will be expected to implement an activity from the workshop within their classroom, and to participate in a subsequent discussion with their local course organiser. A series of prompt questions will be provided to the workshop organisers to assist in facilitating these discussions; the main points will be captured by the workshop organisers (where possible actually during the discussions) and fed back to the evaluation team. The prompt questions will again include contextual information on the level of engagement and backgrounds of the teachers involved, as well as aspects relating to how well teachers were able to implement the Space Awareness activities in their own classroom, and any successes or challenges encountered.

Copies of forms 2-4 above are available in Annexes H2, H3 and H4.

Each node is expected to run at least one workshop with at least 20 teachers as part of their involvement in Space Awareness. The evaluation mechanisms described here form a specific component of the workshop guidelines, and as such will be distributed directly with the workshop contents and instructions. The nodes themselves are thus responsible for

managing the evaluation data collection with their participating teachers. Where possible the evaluation forms will be provided electronically for ease of amendment, completion and submission, though individual nodes may also elect to distribute them in hardcopy if that is more suitable for local use.

The teacher feedback forms will be completed anonymously, though some basic information regarding teacher backgrounds will be requested for context purposes. Likewise, the workshop organiser forms will be completed anonymously and additionally they will be managed directly by the Space Awareness Evaluation lead organisation (UCL) in order to encourage node representatives to be as open and honest as possible in their feedback.

Overall, the combination of these various elements should provide both a robust comparison across different workshops held in different locations, whilst still ensuring sufficient local context to be able to usefully interpret local results.

6.5. MOOCs: evaluation protocol

Four MOOCs (Massive Online Open Courses) are in the process of being finalised by the Space Awareness consortium. Detailed information regarding the development and content of these courses is outlined in D2.2 MOOC report:

- MOOC1: Teaching with Space and Astronomy in Your Classroom[6]
- MOOC2: Our wonderful Universe
- MOOC3: Our fragile planet
- MOOC4: Navigation through the ages

The first MOOC focuses on introducing useful teaching methods based on the agreed Space Awareness General Outcomes (see Section 2) and will begin in September 2016. The other three MOOCs are subject-specific and are related to the three key topical themes within the Space Awareness project. MOOC4 is likely to be launched in November 2016, with the others in 2017. All four MOOCs are hosted on the European Schoolnet Academy platform in order to be easily accessible, benefit from a stable technical platform and also to have a wide dissemination reach from the very start.

The Space Awareness evaluation protocol for the MOOCs has been based on the existing EUN Academy evaluation and assessment procedure, with some adaptations to bring the questions asked in line with the agreed generic outcomes outlined in Section 2. The final framework for the Space Awareness MOOC evaluation consists of four main elements[7]:

- A *pre-course survey* for teachers which gathers key data on participants and contains questions linked to the content of the course and participants' baseline attitudes and confidence within the key target skillset areas. This survey is designed to be distributed two weeks prior to the start of the course.

- An *immediate post-course evaluation* which contains similar parameters as well as immediate impressions relating to the course itself, such as an overall rating, how

[6] This is the public name of the course; within D2.2 for example it has been referred to as *Upgrading teachers' current science practices*.
[7] Examples of EUN Academy pre- and post-course surveys from a previous course are included in Annexe 10 of D2.2 MOOC Report.

well the intended learning outcomes were achieved, to what extent teachers intend to embed the course content within their practice etc. This survey is designed to be completed within a week or two of the course ending.

- A short *follow-up survey* which focuses on potential changes in practice, explicitly investigating whether the teachers have implemented any of the suggested approaches within their classrooms. This survey is designed to be implemented approximately two months after the course ends, to give teachers time to put their plans into action, but not too long to have lost touch with the course itself.

- *Online data tracking*: standard monitoring data will also be gathered from the platform from a technical point of view, like enrolment numbers, number of participants who started and completed each module and activity, etc.

To date the three evaluation surveys mentioned above have been developed for MOOC1, and are provided in Annexes I1, I2 and I3. As the content and focus of the other MOOCs is finalised similar surveys will be developed to evaluate those courses. Note that as with the teacher training workshops described in section 6.4 there will common and specific components to the MOOC evaluations. A common core component contained within all four versions will enable comparison and contrast across the different MOOCs, whilst content-specific aspects will relate to the particular foci of the different courses.

UCL have worked closely with EUN to finalise the details of the survey contents and processes, which are now embedded within the MOOC delivery platform. All three surveys will be distributed to teachers electronically using SurveyMonkey software. The results will be initially reviewed by EUN and the wider MOOC development team (EA, NUC, UL) to inform further development and refinement of the MOOC content and approach; the data will also be supplied to UCL for aggregation and synthesis as part of the overall Space Awareness programme evaluation.

6.6. Other resources and activities

Other components within the Space Awareness programme will also be considered for evaluation purposes as they develop, most notably:

- *Space Scoops* - space news service for children aged 8 and above, designed to be used both by teachers http://www.space-awareness.org/en/scoops/ and pupils directly www.spacescoop.org.

- *Citizen Science activities* – A list of space-related Citizen Science activities is available at www.space-awareness.org/games. A preliminary online questionnaire has been developed for these resources and is currently under revision. Additionally, an MSc student at UL conducted preliminary research in March-August 2015, the findings from which are reported in D3.2 Digital booklet on Citizen Science.

- *Space Career activities* – for example interviews of role models, classroom activities, live webinars, booklet and poster. These activities are planned to be ready in 2017 and the evaluation team will work closely with the resource developers to ensure appropriate inclusion of evaluation elements.

In the majority of cases these activities are being implemented via the Space Awareness website, and thus will be evaluated using the online components described in Section 6.7.

6.7. Online components

The Space Awareness website is a core component of the wider programme, providing a key multi-lingual platform for dissemination and distribution of the majority of the project resources. Additionally, it provides the main hub for information about the project itself. As such evaluating the web usage patterns provides key insights into the operation and success of the Space Awareness project.

As noted in the project timeline, detailed planning for the evaluation of the online components is scheduled to take place in winter 2016, however an overview of the key elements is provided below.

Web analytics

The main tool for web analytics is Google Analytics; the website parameters and initial operation have previously been reported in D5.1 Communication Handbook.

Responsive online tools

In addition to analysing the patterns of web traffic to the site itself, in the final year[8] of the Space Awareness project we will implement a range of responsive evaluative tools to directly investigate user experiences of the resources provided. This will ensure that participants who connect to the project outside of our node network still have an opportunity to feed in their thoughts relating to the various resources and activities. Potential tools include:

- *Pop-up surveys* – Triggered by specific events (such as a user viewing a role model interview video), these surveys will invite participants to provide direct feedback on that experience.

- *Voting widgets* – Embedded into the website structure itself, these short quizzes provide single-issue opportunities for users to provide feedback, for example: “How easy do you find this website to use?” with a short list of options for the user to click on. It is also possible to include simple polls such as “Who are you?” with options for student/teacher/parent/scientist etc. to investigate more deeply who is using the site. The issues can be adjusted over time or selected randomly from a set of pre-defined questions, ensuring wide coverage and a comparatively high response rate.

- *Online feedback forms* – These more detailed feedback elements are embedded (usually as a weblink) within the resources themselves. As part of the resource instructions users are invited to provide feedback via the specific weblink, which takes them to an online survey. For example in the case of the educational resources, the same feedback form as described in Section 6.3 will be provided electronically.

[8] This time period has been determined as the best point in which to gather responsive feedback as the initial revisions from the piloting phase through the nodes will have been taken into account, and web traffic to the resources is likely to be at its highest.

Analysis of social media coverage

Space Awareness has incorporated a range of social media platforms, including Facebook, Twitter, Instagram and YouTube. Where appropriate these will be analysed in two ways:

- *Usage patterns* (using tools such as Facebook Insights and Twitter Analytics) – Similar to the broader website analytics, these tools will provide insights into the backgrounds, interests, geographical locations etc. of the people who connected to Space Awareness via social media. Specific metrics ('likes' and 'shares' on Facebook etc.) will provide an indication of the level of engagement of the social media followers, whilst more detailed analysis of their connections and activity will provide insights into the reach and penetration of the Space Awareness messages.

- *Text-based analysis of conversations* – By tracking specific handles (e.g. @space_awe) or hashtags (e.g. #spacemooc) taking place within the Space Awareness social media community we can create a text corpus for further analysis. These data can be analysed for sentiment (e.g. what sorts of emotions are expressed within the individual comments, and the strength of that expression), as well as common themes.

7. List of Supporting Annexes

There are a large number of supporting documents associated with the Space Awareness Evaluation Framework. Due to their length these documents have been provided in a supplementary online annexe:

Annexe A. Space Awareness Generic Outcomes – full version

Annexe B. Ethical Approval Documents
- Annexe B1. Ethics application – School students
- Annexe B2. School students – Supplementary docs
- Annexe B3. Ethics application – School teachers
- Annexe B4. Ethics application – Current space scientists

Annexe C. Follow-up research information sheet and consent form

Annexe D. Student Baseline Survey
- Annexe D1. Teacher/school information sheet and consent form
- Annexe D2. Opt-out parent consent form
- Annexe D3. Questionnaire
- Annexe D4. Advertising description

Annexe E. Retrospective space scientist survey
- Annexe E1. Questionnaire
- Annexe E2. Advertising description

Annexe F. Role model interviews
- Annexe F1. Scientist information sheet and consent form
- Annexe F2. Interview schedule
- Annexe F3. List of interviewees to date

Annexe G. Educational resources evaluation tools
- Annexe G1. Instructions to nodes
- Annexe G2. Feedback form

Annexe H. Face-to-face teacher training workshops
- Annexe H1. Map of workshop objectives to generic outcomes
- Annexe H2. Workshop feedback form for teachers
- Annexe H3. Workshop feedback form for course organisers
- Annexe H4. Follow-up feedback form for course organisers

Annexe I. Massive Online Open Courses (MOOCs)
- Annexe I1. Pre-course survey for teachers
- Annexe I2. Immediate post-course survey for teachers
- Annexe I3. Follow-up post-course survey for teachers

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