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II.2

Universe Awareness as a Transnational Collaborative Programme in Astronomy Education

Universe Awareness (UNAWE) is a pioneer global science education programme that uses the beauty and grandeur of the Universe to encourage young children, particularly those from an underprivileged background, to have an interest in science and technology and foster their sense of global citizenship. A description is given of the EU Universe Awareness project that was implemented in 6 countries between 2011 and 2013. After showing that targeting young children is highly cost effective we discuss in detail the design and implementation of the project. A framework for evaluating the project was developed and applied, which shows that the project was highly successful in achieving its goals. The implementation of innovations in science education like Space Scoop – astronomy service news for children – and duo internships – teacher training provided by astronomy and teaching students – are also discussed in this chapter. The global network of 61 countries involved with Universe Awareness makes it a truly transnational collaborative programme in science education.

Publication

This chapter is based on Russo et al 2015, Journal of Science Education and Technology (in prep).

1. Introduction

1.1 Background
Universe Awareness (UNAWE) is a unique international programme to use space science and astronomy to inspire very young children, aged 4 to 10 years; it embodies a unique combination of scientific and cultural aspects: our awe-inspiring Universe captures children's imagination, making it a great stepping-stone to introduce youngsters to science and technology. Indeed, many scientists can trace their interest in science to single moments they experienced as young children when they were first introduced to the wonders of the cosmos. Considering the vastness and beauty of the Universe and our place within it provides a special perspective that can help broaden the mind and at the same time stimulate a sense of global citizenship.

UNAWE has been endorsed by the International Astronomical Union (IAU) and is an integral part of the IAU Strategic Plan 2010–2020 Astronomy for the Developing World, a blueprint that aims to use astronomy to foster education and provide skills in science and technology throughout the world, particularly in developing countries (Miley, 2009). In this chapter, we will present and discuss the design, implementation, and evaluation of UNAWE as a transnational collaborative programme in Astronomy Education.

Effectiveness of educating young children. Most pre-university astronomy education programmes focus on secondary school children with the direct goal of stimulating them to choose careers in science and technology. UNAWE uses inspirational aspects of astronomy and space sciences to inspire younger children, because a child's early years have been demonstrated to be highly important for their long-term development.

UNICEF's "Programming Experiences in Early Child Development 2006" report states that educating disadvantaged children in their earliest years offers the best opportunity to give them an equal start in life. *"[This is] when children's brains are developing most rapidly, and the basis for their cognitive, social and emotional development is being formed*," the report states.

The High/Scope Perry Preschool Study (HSPP) is an example of what investing in the education of young disadvantaged children can achieve in the long-term. Beginning in the 1960's, HSPP randomly divided 123 disadvantaged African-American children aged between 3 to 4 years into a group that received a pre-school programme and a control group that received no intervention. HSPP maintained contact with the study's participants every year until the age of 11, and then conducted follow-up interviews at ages 14, 15, 19, 27 and 40. In 2005, a study of 97% of participants (then aged 40) revealed that those who had taken part in the pre-school programme achieved greater success in life than the control group such as experiencing higher graduation rates, better paid jobs, and – most importantly – fewer criminal records (Schweinhart, 2005).

However, despite the greater successes in the children's later life in the HSPP pre-school group, these children did not achieve higher IQ scores than the

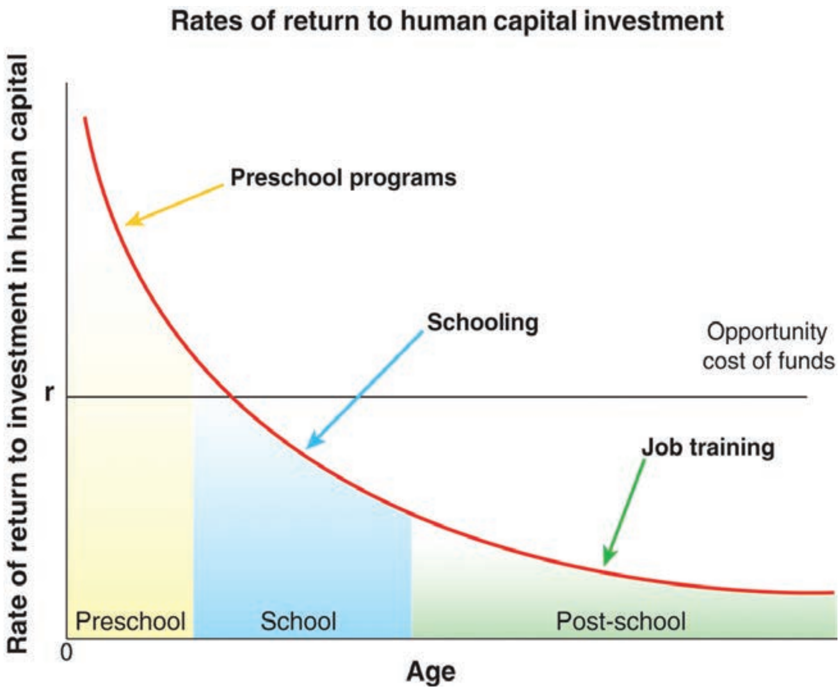

Figure 1. Rates of return to human capital investment in disadvantaged children. Credit: Science Magazine / Heckman.

control group when they were tested at the age of 10. They did, however, achieve greater success in life because they had improved non-cognitive abilities such as motivation and perseverance (Heckman, 2008).

A further conclusion of the study was that the programme had also been an economic investment for society (Schweinhart, 2005). Overall, $15 166[01] was spent on the pre-school programme, but the economic return to the general public was calculated to be an astounding $195 621– a $12.90return per Euro invested, mostly due to decreased crime-related costs[02].

According to Heckman (2006), who has reviewed a large body of economics and developmental psychology research, the rate of return would have been lower if the investment in education was instead made when the disadvantaged children were older. Figure 1 displays Heckman's depiction of the relationship between age of intervention and the benefit-to-cost ratio of an educational programme. Heckman's work shows that based on the HSPP follow-up, investing in education during a child's earliest years is not only worthwhile, but also represents the most appropriate time to intervene.

1.2 Astronomy & Young Children

From the age of 4, children can readily appreciate and enjoy the beauty of astronomical objects and can learn to develop a "feeling" for the vastness of the Universe. On the one hand, the Universe is an excellent and exciting vehicle for introducing the scientific method and the concept that nature can

[01] United States Dollars

[02] Education savings, taxes on earnings and welfare savings represent $24 149.

be interrogated by rational means (Baram-Tsabari & Yarden, 2009). On the other hand, exposure to inspirational astronomical observations and space data can broaden a child's perspective and mind while stimulating a global perspective.

Some developmental psychologists have hypothesised that young children form naïve theories about the Earth based on what they witness (e.g., the world around them appears flat, and objects need a surface to stand on; therefore, they believe Earth is flat and supported by another object). Proponents of this hypothesis (Vosniadou, 1994 a, b), say that counter-intuitive scientific theories are difficult for young children to accept and that scientific explanations about how the Universe works can only be introduced at later stages of a child's education (around 10 years old), once they become aware that their naïve theories are wrong. However, there is a growing body of research that disputes this "naïve theories" hypothesis, claiming that children are "theory neutral." In these studies, developmental psychologists argue that children build up a picture of the Earth in a fragmented fashion, and there are no strong intuitions and misconceptions to overcome (Nobes, 2003; Siegal, 2011; Panagiotaki, 2008). Therefore, children can gradually learn and accept scientific explanations of the world around them from a young age.

Panagiotaki (2008) states that children as young as four years old are able to understand basic scientific ideas. "*Even though children are often not able to explain their ideas in great detail, scientific information and facts can be present from early on. [...] Children benefit enormously for appropriate instruction and educational activities aimed at teaching them basic facts.*" Liberman (2012) shows that learning about distant objects promotes more abstract thought. When visualizing proximal objects, individuals tend to use concrete and detailed images while picturing distant objects, such as those often dealt with in astronomy, in a more abstract and decontextualized way. Liberman found that after spatial distance priming, children are more creative in both fluency and originality. Moreover, Sjøberg and Schreiner (2010) have shown that Space and Life in Outer Space are the most interesting topics for pupils, both boys and girls, across several countries.

Introducing young children to astronomy is challenging, especially in a multi-national project that must consider many different local cultures. However, much of the current literature regarding children's cognitive development indicates that a project, such as EU-UNAWE, is of great benefit to the youngsters that it reaches. Time and time again, a child's early years are shown to be the most crucial in determining their future prospects.

Underprivileged Communities. Astronomy is an important tool for motivating young children in underprivileged communities, thereby helping to alleviate social problems and build the knowledge and innovation economy. Early educational interventions during the young formative years are crucial in stimulating child development (OECD, 2006, Worth & Grollman, 2003, Rocard 2007). Furthermore there is an enormous untapped potential and talent in underprivileged communities. Such communities are frequently alienated from society at large and this alienation begins at childhood. According to a UNICEF report (DATE), "*The opportunity to help disadvantaged children have* *a more equal start in schooling is in the earliest years when the basis for their cognitive, social and emotional development is being formed*". Educating very young children from underprivileged communities is highly cost effective (Schweinhart et al 2005), but needs a special approach. The Early Years Learning Framework for Australia (2009) states, "*When early childhood educators respect the diversity of family and communities…they are able to foster children's motivation to learn*" and further "*Poor math trajectories in low-socioeconomic status children begin early…. Studies suggest that early interest can be influenced*" (Arnold and Doctoroff 2003). However, it is clear that further such studies are needed in a range of diverse environments and cultural settings.

1.3 Components of Universe Awareness

Universe Awareness' goal is to inspire young children and encourage them to develop an interest in science and technology. The programme also aims to introduce children to the idea of global citizenship at a crucial stage of their development – to show them that they are part of an international community. Universe Awareness exploits several tools and activities to achieve the top-level goals of the programme taking account of the theoretical framework presented above. These include:

Teacher training. A particularly important UNAWE ingredient is to provide training activities for teachers and other educators of young children. UNAWE aims to give teachers the confidence necessary to introduce astronomy and other science topics in the classroom and create innovative methods for engaging young children in astronomy. To achieve this goal, UNAWE organises teacher training workshops. In section Teacher Training, we will discuss teacher training activity implementation in detail.
Development of localised educational resources. Learning should be creative, exciting, and interesting (Abadzi et al., 2014). UNAWE develops resources using the pedagogical method of inquiry-based learning (Bell et al., 2010). In section Educational Resources, we will discuss educational resources development of in detail.

An international network. The international network provides a platform for sharing ideas, best practices, and resources between educators from around the world and guarantees understanding of cultural differences when developing resources. UNAWE is a multi-national programme, so it is also important to note the impact that local cultures play in educating young children. In a background paper for the UNESCO "Education For All Global Monitoring Report 2007," Arnold et al. claim that education programmes that are not responsive to local cultures will suffer from lower enrolment and retention levels (Arnold, 2006). The researchers argue that education programmes, which are at odds with local cultures, can be viewed by parents as having a damaging effect on their children's welfare. UNAWE recognises the importance of considering local cultures and uses local experts who understand the local cultural needs and histories to effectively implement its activities in each partner country (Samarapungavan, 1998).

Evaluation and impact assessment. Evaluation is the analysis of on-going or completed activities and an effective way of learning how to better perform tasks and apply ideas (Russo & Barrosa, 2008). It is a way of collecting information that helps all those who manage projects to understand and justify the results and impacts as well as build best practices. For UNAWE, evaluation is a source of learning. Through evaluation, UNAWE does the following:

- Determines if the programme objectives were reached
- Obtains information on the programme outcomes along with suggestions for improvement
- Identifies the changes resulting from programme implementation
- Identifies ways in which the programme could have been more effective and efficient
- Identifies unexpected results
- Develops ideas about the programme and what it intends to achieve
- Provides encouragement by demonstrating that one's efforts have been worthwhile
- Guarantees intercultural attitudes.

In section 4, we will discuss the evaluation framework of UNAWE and the programme's impact assessment in detail.

1.4 Genesis of EU-UNAWE

EU Universe Awareness (EU-UNAWE) was initiated in 2011 when the European Union awarded a 7th Framework Programme (FP7) grant of 1.9 million Euros to fund a 3-year project to build on the existing UNAWE programme's work (CORDIS, 2015). The FP7 grant supported the development and implementation of UNAWE programmes in six countries: Germany, Italy, The Netherlands, the United Kingdom, South Africa, and Spain. South Africa's inclusion in the EU-UNAWE evidences the close collaboration in the fields of science and technology that the country has developed with the European Union.

2. Design of the EU-UNAWE Programme

2.1 Objectives

The EU-UNAWE proposal contained several specific objectives as part of the EU-UNAWE implementation of Universe Awareness. The objectives were categorized by operation in conjunction with the programme's managerial processes (Table 1), and cognitive objectives regarding the skillsets, abilities, and processes related to knowledge (Table 2). The cognitive objectives and skills were further developed into an evaluation framework (discussed in detail in the discussion sections)

Table 1. Overview of EU-UNAWE Operational objectives and respective evaluation estimators.

EU-UNAWE Operational Objectives	Evaluation estimators
Train and empower primary school teachers in 6 countries to include astronomy and space topics in the classroom	Number of teachers trained.
Develop and translate hands-on material where appropriate, emphasising the EU and SA science and technology	Number of resources produced and distributed.

Provide a network for exchange of expertise and material between educators - Lay the groundwork for programme expansion throughout the European Union and Associated Countries	Number of educators engaged. Number of Universe Awareness National Nodes.
Act as a showcase for the EU and SA astronomy/space and related technologies by disseminating the products among very young children, their teachers, and families.	Number of exchange activities between the EU and South Africa.
Use astronomy/space products to stimulate awareness and strengthen public support for the EU and SA space science research and technology.	Number of activities engaging general public.
Stimulate the next generation of EU and SA engineers and scientists, particularly girls.	Number of activities targeting girls.
Contribute to the integration of disadvantaged communities in participating countries.	Number of activities engaging disadvantaged communities.
Strengthen collaboration between the EU and SA over mutually-beneficial scientific, technological, educational, and social topics.	Number of exchange activities between the EU and South Africa.
Provide significant added value for Europe's expenditure on astronomy and space sciences for a modest incremental cost.	Number of educators and children reached by astronomy and space sciences activities.
Pooling complementary expertise and partner resources makes for a project whose whole is greater than the sum of its parts.	Number of resources produced for the EU-UNAWE consortium.

Table 2. EU-UNAWE Cognitive Skills and Objectives

EU-UNAWE Cognitive Skills	**Cognitive Objectives**
Motivation	Enjoyment Inspiration Curiosity Tenacity

Scientific Skills	Develop Scientific Thinking and Problem Solving Techniques: • Planning and Conducting Investigations • Discussing and Questioning • Planning • Observing • Interpreting • Ideas and Evidence • Recording • Evaluation
Knowledge	Knowledge and understanding of astronomy and space–related concepts
Intercultural Attitudes	Valuing different cultural perspectives Recognising different physical perspectives of the Earth Positive attitude towards astronomy Working individually and in teams

2.2 Teacher Training

The effectiveness of reaching children is increased significantly through the multiplicative effect of targeting their teachers. Except for professional science educators, teachers are often afraid of science, engineering, and mathematics (Peacock, 1991; Beilock et al., 2009). This is a particularly acute problem for many primary school teachers who have a substantial influence on young children's initial school years. Exposure to astronomy-oriented topics can build confidence in teachers and sow the seeds of a science-oriented future career choice. Furthermore, teacher training is a crucial instrument for encouraging science, technology, engineering and mathematics (STEM) literacy and interest in astronomy among the general public.

EU-UNAWE training courses (also known as CPD – Continuous Professional Development) are embedded in a conceptual framework that demonstrates how to integrate astronomy and space-related activities successfully into the classroom in both formal and informal settings. The framework is based on the pedagogical approach of Inquiry Based Science Education (Rocard et al., 2007) with an inquiry cycle that specifically targets space-related activity implementation in different settings and grade levels. The sets of activities will demonstrate the connection between natural phenomena, and the concepts behind them and will show the progression from small to large scientific ideas. During the training sessions, teachers gain subject knowledge for teaching their pupils in the domains previously explained. In addition, there is potential for the programme impact to significantly increase through teachers disseminating knowledge to pupils, critically appraising resources and activities in order to make recommendations for future projects, and embedding astronomy activities into curriculum.

2.3 Educational resources

Inquiry-based learning techniques were taken into consideration in EU-UNAWE educational resources design. All necessary background information and a clear step-by-step "walkthrough" were included so that educators can implement the activities regardless of their scientific background. In addition, all subject matter can be linked to the curriculum to help teachers incorporate the activities in their lesson plans. EU-UNAWE resources are open source and produced using a Creative Commons License (Attribution-Non-Commercial-Share Alike 4.0 Unported). This closely follows the recommendations from the European Commission on Open Education and Open Access. Moreover, this approach allows the global UNAWE network to localise the educational resources. The crowd-sourced efforts and online educational resources therein increase the impact of astronomy outreach and education (Ödman-Govender & Kelleghan, 2011). The EU-UNAWE resources have been designed to be low-cost and are available for free under the Creative Commons License in a range of formats for ease of use, adaptation, and translation.

2.4 Web Communication

The EU-UNAWE website was launched in June 2011 and is the central hub for all of the programme's news, activities, and educational resources. Since its launch, the website has seen an increase in visitors each month (Figure 2). In addition to hosting all of the EU-UNAWE educational materials (currently 70 items), there has also been a stream of regular news updates. This flow of information engages educators and shows that EU-UNAWE is an active project while also inspiring them with ideas for new educational activities. The EU-UNAWE national websites have been developed using the same technology and visual identity as the international EU-UNAWE sites. The national EU-UNAWE websites complement the international website by providing information about events and resources that are country-specific and written in the country's national languages. The EU-UNAWE websites were developed with a coherent web infrastructure for each partner. The websites use Djangoplicity, an astronomical digital asset management system based on the Django Web Framework, which is also used for websites such as The International Year of Astronomy 2009 (Russo et al. 2008).

2.5 Evaluation Framework

Based on the EU-UNAWE programme's background information and the educators' input, initial concepts were produced to develop a coherent evaluation framework across the EU-UNAWE programme. These were discussed by the EU-UNAWE team and the following list of actions and concepts to be introduced was agreed upon, in preparation for the final Evaluation Framework:

1. Stimulate via images, playful activities, experiments, and models children´s awareness of the sun, the moon, the Earth as a planet and their related phenomena (day and night, tides, eclipses, and seasons), other planets, the stars in our galaxy, other galaxies, and their clusters and be-

yond. In doing so, try to use household materials in the activities, experiments, and models so that children can reproduce them at home.
2. Stimulate children giving them time and the occasion to formulate their own questions and to broaden their view of the "world" while delivering the program.
3. Create occasions for direct observations of the sun, moon, stars, and planets, taking into account school breaks, timelines, excursions, and project days.
4. Motivate children to appreciate other cultures (via stories and Skype conversations with children living in other countries), making them aware of the place in which other children live, their common cultural features, and differences.

These initial concepts suggested a framework is appropriate for EU-UNAWE evaluation that covers a range of learning domains linked to cognitive objectives, which are respectively as follows:

1. Astronomy awareness (knowledge)
2. Curiosity
3. Observation skills
4. Motivation and engagement
5. Global cultural respect

The final EU-UNAWE framework (Kimble et al., 2013) was based on the US Informal Science Education framework (National Science Foundation, 2008), Earthsmarts' Conceptual framework (Nichols, 2012), and Generic Learning Outcomes (Museums, Libraries and Archives, 2008).

Using these models as a basis, the domains of learning were defined. Corresponding evidence was identified before methodologies and draft materials were produced for comment. These included pre- and post-visit activities appropriate for different age groups using a drawing methodology derived from Personal Meaning Mapping (Falk and Dierking, 2000). For younger children, a behaviour observation template was outlined using methodology derived from Barriault and Pearson's work on behaviour analysis (2010). Moreover, EU-UNAWE produced surveys for children and teachers as well as a data collection process outline and template letters for teachers and parents. Ethical conduct codes were followed in the consent letter production for participation and visual evidence, such as photos or videos.

The EU-UNAWE framework encompasses both formative and summative evaluation. Summative evaluation is characterised as assessment of learning while formative evaluation is assessment for learning. Each national EU-UNAWE team undertook formative evaluation appropriate to their capacity and resources, in order to develop the optimum programme for their country. The national programmes used teacher questionnaires as a methodology to collect data. Data shows evidence of the summative programme impact, and therefore, these areas will be highlighted in this chapter, which focuses on summative evaluation.

Table 3. EU-UNAWE Evaluation Framework

EU-UNAWE Cognitive Objectives		**Evidence**
Motivation	Enjoyment Inspiration Curiosity Tenacity	Children are performing the tasks with pleasure Children seem enchanted Children react with diligence towards the proposed activities Children demonstrate attention Children apply perseverance/ tenacity Children manifest inquisitiveness Children introduce some complex questions

Scientific Skills	Develop scientific skills, for example: • Develop Scientific Thinking and Problem Solving Techniques; Planning and Conducting Investigations • Observation, Identification, Classification, Making interconnections, Changing Perspective and Communication • Discussing and Questioning • Ask questions that can be answered through an investigation • Use scientific language regularly in discussions • Planning • Plan and carry out tests to collect evidence • Select information from a range of resources • Observing • Decide what observations must be made • Select appropriate equipment for observation or measuring results • Interpreting • Draw conclusions linked to scientific knowledge and understanding • Recognise patterns and trends based on the observation or investigation • Ideas and Evidence • Recognise that scientific ideas are based on evidence which can be verified by observations • Use the imagination together with scientific knowledge to understand and think about why something happens • Recording • Decide on an appropriate recording method • Present results using tables, graphs, and pictures • Evaluation • Review the work and reflect on the results	• Correct use of vocabulary or gestures to name objects and phenomena observed in the sky • Grouping objects/ phenomena to indicate developing understanding of astronomy concepts • Making conjectures available to be contrasted • Developing some experiences related to the hypothesis • Linking new information with existing conceptions of the same or different areas • Removing previous points of view according to new inputs • Sharing with others their new knowledge

Universe Knowledge	Knowledge & Understanding Observing, exploring and discovering: • The Sun, its relative position, sunlight (shadows), day/night cycle, time zones, the seasons, the Moon, the Earth as a planet, awareness of how water, the Earth's atmosphere and sunlight are needed for the development of life on Earth, solar and lunar eclipses, etc. • The Solar system: planet characteristics and movements, dwarf planets, asteroids, comets, etc. • Stars in the night sky, constellations, orientation, life-cycle of stars, formation of stars and planets, etc. • Our place in the Milky Way, family of galaxies, etc. • Current developments in astronomy • Magnetic fields (compass, northern lights, etc.)	Direct observation and/or recording of naming, first explanations, discussing, drawing, construction, creative responses, movements, and dances, etc. to demonstrate knowledge of one of the features listed in the left column.
Intercultural Attitudes	• Valuing different cultural perspectives • Recognising different physical perspectives • Positive attitude towards astronomy • Valuing inclusive education • Working individually and in teams	• Demonstrating awareness of different cultures • Ability to observe and explain differences in phenomena in different countries • Statements of future activity with regards to astronomy • Acting appropriately in a frame of diversity

The EU-UNAWE evaluation framework was developed to meet the needs of a 3-year programme. A longitudinal evaluation would be needed in order to assess the long-term impact for pupils who have participated in UNAWE activities. Methodology and capacity to carry out such in-depth future research would be beneficial to the astronomy education field.

3. Implementation of the EU-UNAWE Programme

3.1 Teacher & Pupil Engagement

EU Universe Awareness is, first and foremost, an educational programme for children and educators aimed at inspiring young children from every corner of the world to take an interest in science and technology and develop a sense of global citizenship. Throughout the project's duration (2011-2013), several-thousands of children and educators were engaged in EU-UNAWE related activities, from teacher training to direct activities with children. Table 4 provides an overview of the numbers reached by the project in the 6 participating countries as well as the list of the organisations and personnel involved.

Table 4. EU-UNAWE project overview and impact numbers.

	Italy	**Germany**	**The Netherlands**	**United Kingdom**	**Spain**	**South Africa**	**Total**
Institution	INAF - Arcetri Astrophysical Observatory	Haus der astronomie / University of Heidelberg	Leiden University	Armagh Observatory and Planetarium	Universitat Politecnica de Catalunya	National Research Foundation – South African Astronomical Observatory	
Coordinator	Franco Pacini and Filippo Mannucci	Andreas Quirrenbach	George Miley	Mark E. Bailey	Rosa Ros and Jaime Fabregat	Sivuyile Manxoyi	
National Project managers	Alessandra Zanazzi and Lara Albanese	Natalie Fischer and Cecilia Scorza	Wouter Schrier and Erik Arends	Libby McKearney	Eloi Arisa and Alexandra Stavinschi	Troshini Naidoo	
Number of teachers trained	393	348	487	328	286	531	2372
Number of children reached	11 217	11 253	15 652	26 872	10 950	5 984	81 892

3.2 Communication

The EU-UNAWE websites comprised the programme's main communication tool. Each national project had national websites consisting of both national organisation websites and national resources websites. The websites contained information about the programme with news and educational resources in the national language.

Table 5. EU-UNAWE communication tools overview, including social media, as of 31 December 2013.

Communication tool	Impact Numbers
Facebook	1 960 followers
Twitter UNAWE	4 155 followers
Twitter UNAWE_NL	103 followers
Google +	150 followers
Flickr	1 700 pictures published
SlideShare	128 presentations (UNAWE account was one of the top 2% most-viewed SlideShare accounts in 2013)
ISSU	108 documents
International mailing list	1 609 subscribers

Table 6. Statistics for EU-UNAWE websites from 1 January 2011 to 31 December 2013

Website	Website	Number of Visitors	Unique Visitors	Page views	Pages/ Visit	% new visits (%)
International	www.eu-unawe.org	179 915	121 271	500 289	2.78	67.40
Germany	http://de.eu-unawe.org	2 805	1 576	9 070	3.23	55.61
Spain	http://ed.eu-unawe.org	18 643	14 400	52 767	2.83	77.12
Italy	http://it.eu-unawe.org	4 499	3 260	15 116	3.36	72.10
The Netherlands	http://nl.eu-unawe.org	13 763	9 780	31 475	2.29	70.78
The UK	http://uk.eu-unawe.org	3 189	2 407	7 399	2.32	75.07
South Africa	http://za.eu-unawe.org	1 237	705	3 660	2.96	56.75
Total		224 051	152 799	616 482		

3.3 Educational Resources

Educational resources developed in the context of the UNAWE project were collected and published on the project websites. Many UNAWE network members contributed translations, which were also made available on the sites.

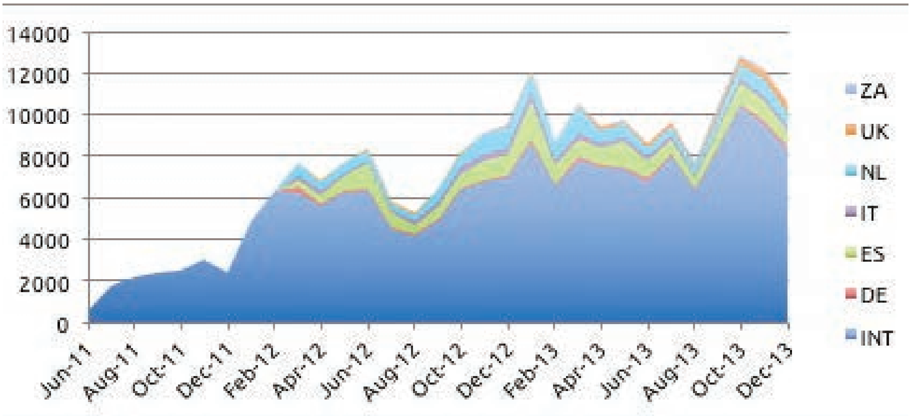

Figure 2. EU-NAWE Websites Statistics Overview: Cumulative number of visitors of different EU-UNAWE websites from January 2011 to December 2013.

The resources were checked for scientific accuracy by qualified astronomers and for pedagogical quality by experienced educators. Four of the educational activities were peer-reviewed through the IAU astroEDU platform (Chapter III.1). Table 7 presents an overview of the different resources pro duced during the EU-UNAWE programme as well as additional information about the impact and distribution.

Table 7. Overview of the different resources produced during the EU-UNAWE programme.

Resource	Type	Target	Domain of Learning	Impact	Additional Information
Earth Ball and handbook	Physical Resource (Handbook also available in PDF)	Children and Educators	Motivation, Scientific Skills, Knowledge, and Intercultural awareness	7 000 distributed	
Universe in a Box	Physical Educational Kit(Handbook also available in PDF)	Educators	Motivation, Scientific Skills, Knowledge, and Intercultural awareness	750 distributed	Discussed in Chapter III.2
Space Scoop	Astronomy news articles (digital)	Children	Scientific Skills and Knowledge	255 Space Scoops in 28 languages	www.unawe.org/kids/

Levitating Astronaut	Digital Peer-reviewed resource	Educators	Scientific Skills and Knowledge	Available in English	Roberts, S., 2014, *Levitating Astronaut*, astroEDU, 1407, doi:10.14586/astroedu.1407
Model of a Black Hole	Digital Peer-reviewed resource	Educators	Scientific Skills and Knowledge	Available in English	Turner, M., 2013, *Model of a Black Hole*, astroEDU, 1304, doi:10.14586/astroedu.1304
Lunar Landscape	Digital Peer-reviewed resource	Educators	Scientific Skills and Knowledge	Available in English	Ramchandani, J., 2013, *Lunar Landscape*, astroEDU, 1311, doi:10.14586/astroedu.1311
Deadly Moons	Digital Peer-reviewed resource	Educators	Scientific Skills and Knowledge	Available in English	Kelleghan, D., 2014, *Deadly Moons*, astroEDU, 1404, doi:10.14586/astroedu.1404
Kamishibai – Stella & Giotto	Physical educational kit (also available digitally in PDF and iBook)	Children	Motivation, Scientific Skills, Knowledge and Intercultural awareness	Available in Italian, English and Dutch	https://itunes.apple.com/nz/book/stella-giotto-
Cosmos in Your Pocket	Activity book (also available in PDF)	Children	Motivation, Scientific Skills, and Knowledge	20 000 distributed in 17 languages	www.unawe.org/updates/unawe-update-1367/
UNAWE Booklet Collection	7 Activity and Storytelling books (also available in PDF)	Children and Educators	Motivation, Scientific Skills, Knowledge, and Intercultural awareness	Available in 5 languages	http://es.unawe.org/resources/books/

The Invisible Universe	Activity book about radioastronomy	Children	Motivation, Scientific Skills, Knowledge, and Intercultural	Available in English and Dutch	www.unawe.org/resources/education/Radioastronomy_activity_booklet/
Into a Black Hole	Digital educational book (iBook)	Children	Motivation, Scientific Skills, and Knowledge	Available in English	https://itunes.apple.com/us/book/into-
Astronomers vs. Kids	Set of educational videos with Nobel Prize Winner Brian Schmidt	Children	Motivation, Scientific Skills, and Knowledge	Available in English with Dutch subtitles. More than 1500 plays	www.unawe.org/updates/unawe-update-1322/
The Dreamgazer	Educational Video produced by children	Children	Motivation, Scientific Skills, and Knowledge	Available in Dutch with English subtitles.	www.unawe.org/updates/unawe-update-1362/

EU-UNAWE Human Orrery	Physical educational installation	Children	Motivation, Scientific Skills, and Knowledge	Implemented in King's School in Peterborough (UK), Christ the Redeemer Primary School (UK) in Belfast, and Eureka High School, Kathmandu (Nepal)	http://www.unawe.org/static/archives/presentations/pdf/2012workshop_baileyi_human_orrery.pdf

3.4 Case Study: Space Scoop

An innovative resource developed in the course of the project was "Space Scoop", a news service for older children. The idea behind Space Scoop is to change the way science is often perceived by children as an out-dated and dull subject (Allodi, 2002). By sharing exciting new astronomical discoveries with them, we can inspire children to develop an interest in science and technology. Space Scoops are short news articles about astronomical discoveries written in a child-friendly language and accompanied by a stunning astronomical image. Space Scoop is a wonderful tool that can be used in many different settings to teach, share, and discuss the latest astronomy news.

The main educational goals of Space Scoop are as follows:

- Share the excitement of new discoveries with children.
- Show that there is still potential for contributions in the area.
- Enhance understanding of the world and encourage critical thinking.
- Broaden children's minds and cultivate world citizens.

Each Space Scoop begins with a new discovery or observation in the field of astronomy and space science. Partner organisations (e.g., ESO[03], NAOJ[04], ESA[05], NASA[06]) then prepare a press release which undergoes a critical science check before being sent to us where the release is translated into a

[03] ESO – European Southern Observatory

[04] NAOJ – National Astronomical Observatory of Japan

[05] ESA- European Space Agency

[06] NASA – National Aeronautics and Space Administration

child-friendly language. Similarly, Space Scoop undergoes an internal educational review to assure the highest quality. The final texts are then sent to our group of volunteer translators from all over the globe, where they are translated into 33 different languages. Finally, the Space Scoops are released to the public at the same time as the original press release to ensure that kids, much like adults, can keep up-to-date with the latest discoveries.

Space Scoop is a versatile resource which can be adapted to many different formats and digested by many audiences, including various age groups, the visually-impaired, illiterate, those without internet access, etc. Space Scoop is already being used by children, teachers, astronomers, museums, and more (see table 8). Some examples include *Anorak*[07], a children's magazine, and *Timbuktu*[08], an interactive digital magazine for children, American Association for the Advancement of Science, "Eurekalert!", a global news service featuring each Space Scoop in their "News Reporting for Kids" section[09], Goa's *Nahvind Times*[10], Dutch science magazine, *Universum*, *Wired.com,* the popular Indonesian website, "Langitselatan," *National Geographic Indonesia*, and the Slovenian magazine and website, *Portal v Vesolje*. Additionally, the Space Scoop article, "The Universe is Big, Beautiful...and Mostly Invisible," has been featured in an official South African textbook (Spring 2013) which is used in primary schools all over the country, reflecting the quality of Space Scoop in terms of both scientific and educational content. Space Scoop content is also used in the Cambridge University Press English Language Book, *IGCSE English as a Second Language*[11].

Today, for most parts of the world, digital media is exceedingly accessible, able to reach a mainstream audience of the tech-savvy young generation (Rosen 2010), and if presented correctly, this format can attract even more readers. In response to this demand, a Space Scoop app[12] has been created for Android mobile devices. Space Scoop can also be used as the basis for educational activities. Space Scoop Storytelling uses the articles as the basis for a creative cross-curricula activity that touches on astronomy, literature, presentation skills, and more.

Table 8. Space Scoop Impact Numbers from March 2011 to November 2013.

Number of Space Scoops published	196
Languages in which Space Scoops are available	22
Number of Space Scoops translated	2108
Number of Space Scoop Partners	10

[07] www.anorakmagazine.com
[08] www.timbuktu.me
[09] www.eurekalert.org/kidsnews/
[10] www.navhindtimes.in
[11] http://www.amazon.com/Cambridge-IGCSE-English-Second-Language/dp/1444191624
[12] The app can be downloaded here: https://play.google.com/store/apps/details?id=com.gdogaru.spacescoop

Page views on UNAWE website	100,000 (80% unique page views)

3.5 Case Study: Innovation in Teacher Training: *Universe in the Classroom*

During the school year of 2009-2010, Universal Awareness (UNAWE) organized and coordinated a pilot project in teacher training called duo internships. During these internships, aspiring primary-school teachers and astronomy university students were coupled to develop astronomy lessons and to implement those lessons at primary schools. Throughout this pilot, 16 duos participated in activities at primary schools in Groningen, Arnhem, Den Haag and Utrecht (the Netherlands). The combination of an astronomy student and an aspiring teacher guarantees quality both ways, astronomy lessons were both scientifically correct and pedagogically sound. Interns learned from each other: Astronomy students learned how to explain science with more comprehensive words, while aspiring teachers experienced young children's fascination with science in addition to learning how to make science accessible via approachable, hands-on exercises. As a follow-up to this pilot activity, in 2014 astronomy students from Leiden University paired up with trainee teachers from the teacher training school *Hogeschool Inholland* (Rotterdam) in a project designed to introduce the Universe to children in three primary schools in the second-to-largest city in the Netherlands, Rotterdam. Each student pair developed educational astronomy materials and gave their own classes. Similar to previous results, this scheme allowed children to learn about astronomy, as well as both students within a pair to learn from each other. The trainee teachers learned about astronomy and science in general, and the astronomy students gained experience in how to communicate science to young children and explain difficult concepts in simple terms.

3.6 International Workshops

EU Universe Awareness International Workshops have provided educators, teachers, astronomers and members of the UNAWE network with an opportunity to come together and share ideas, techniques, and resources developed by the programme. The first EU-UNAWE International Workshop was held at Leiden University, the Netherlands, in March 2012, drawing participants from 28 countries. In October 2013, the second EU-UNAWE International Workshop took place at the *Haus der Astronomie* in Heidelberg, Germany, and the number of participating countries rose to 40 with a total of 60 participants.

One goal of the workshops was to consolidate existing EU-UNAWE astronomy education and communication resources for very young children. Participants also discussed, in depth, the role of astronomy and space science in early childhood development, curricula development, culture in astronomy education, global capacity building and evaluating the long-term effectiveness of exposing very young children to inspirational and motivational astronomy activities. During the discussions, a number of action points arose which the EU-UNAWE international network then endeavoured to implement. On the topic of curricula for different ages, it was found that teachers need guidelines for suitable topics to introduce into their classroom, but these should take into consideration the different ages that children start school around the world. Furthermore, children in remote villages do not have the same resources at home to follow-up with classroom topics as children in cities. It was proposed that guidelines for suitable topics should be provided in stages or levels, rather than associated to a specific age group, with recommendations for what stages should be used that are based on, for example, the school's location.

Workshop members recognised the need for an online platform to act as a central hub for the many educational materials that are available around the world, which EU-UNAWE began to implement through the repository on its website, and developed further with IAU astroEDU. Another important topic for the international UANWE network is culture in astronomy education and the need to collect high quality materials about the connection between culture and astronomy as it is currently difficult to find such resources. During the workshops, it was noted that the programme must work to fill available material gaps as many stories about astronomy in indigenous cultures have not yet been recorded in a written format. The international workshops are an essential platform to build the UNAWE community, and the current plan is to organise a workshop every two or three years.

3.7 Exchange Programmes Case Studies

Exchange Activities within EU-UNAWE. An important benefit of the Universe Awareness network is the ability of educators in different countries to exchange experiences and learn from each other. This was stimulated in the EU-UNAWE project through several physical international exchanges of team members. EU-UNAWE Italy participated in two exchange activities with other partners. In January 2012, they were invited to Northern Ireland to take part in the BBC's annual Stargazing LIVE event. EU-UNAWE Italy performed their shadow theatre show, "Galileo Galilei: a sky full of discoveries" and other science activities for about 150 children from four different schools (http://uk.unawe.org/updates/UKEvents/).

From July 30 to August 7, 2012, the Italian team joined EU-UNAWE South Africa during the country's National Science Week. Together they visited five schools located in disadvantaged areas of Cape Town and two schools in Sutherland. At a planetarium, children enjoyed hands-on workshops. The events also offered teacher-training sessions, which included a Skype connection with Italian teachers, allowing participants to exchange experiences and ideas. (http://www.unawe.org/updates/unawe-update-1260/).

The South African Skype programme's success prompted EU-UNAWE Italy to arrange similar events for schoolchildren. During the Skype calls that followed, students not only exchanged results from their scientific investigations and lessons, but songs and stories about the night sky as well.

Skype Exchange Programmes. In the summer of 2013, the EU-UNAWE programmes of South Africa and the Netherlands joined together to organise a collective project with primary school students in Buffalo City (South Africa) and Leiden (the Netherlands). The project challenged students to observe the Moon for a full month, from 21 May till 21 June, to learn about the seasons and the lunar phases. By comparing their observations, the children discovered some important differences between the Northern and Southern Hemispheres. For example, they noticed that the Moon appears “upside down” to the other half of the world and that the seasons appeared at different times in different countries.

3.8 Outreach to Policy-makers

Lobbying within the EU Parliament is an additional but important activity that has been employed to increase the impact of EU-UNAWE on policymakers. Not only do such activities contribute to the visibility of EU-UNAWE, but they are also important for demonstrating the social and political relevance of the European astronomy programme and the long-term sustainability of pan-European astronomy education programmes. Throughout the EU-UNAWE programme several activities at the European Parliament were implemented alongside added support from additional Members of the European Parliament.

Table 9. EU-UNAWE impact with parliamentarians

Event/Activity	Date	Parliamentarians Engaged	EU-UNAWE Participation
Science and Technology Options Assessment Workshop: *Importance of astronomy* (EU Parliament)	24 May 2011	T. Riera Madurell, MEP S. Tatarella, MEP	Invited Talk G. K. Miley Invited Organisation G. K. Miley, P. Russo
EU Universe Awareness Workshop (Leiden University)	26 March 2012	G. Mitchell, MEP T Riera, Madurell MEP, E. Ngcobo MP, Chair, South African Parl. Comm. on Science and Technology B.J. van Bochove, Chair, Netherlands Parl. Comm. for Education, Culture and Science	Organisation G. K. Miley, P. Russo Talk G. K. Miley
Science For Global Development: Astronomy– A Case Study	6 March 2012	W. Newton Dunn, MEP	Invited Convenor and talk G.K. Miley Report in Plenary Session in presence of Irish Taoiseach G. K. Miley

Parliamentary questions to Commission urging EU-UNAWE continuation	15 May 2013	A. Smyth MEP EN E-002852/2013 EN E-002853/2013 Available on European Parliament website: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+W-	Lobbying
Additional pledges of support	March 2013	L. Aylward MEP T. Berman MEP J. Evans MEP M. Harbour MEP F. Kaczmarek MEP V. Prodi MEP	Lobbying

A conclusion that we draw from EU-UNAWE lobbying activities is that programmes, such as EU-UNAWE, which provide a bridge between scientific research, society, and education, are attractive to policymakers. They are therefore a cost-effective way of demonstrating the social relevance of astronomy and space sciences

4. Evaluation

In order to investigate impact, different methodologies based on quantitative and qualitative methods have been used. Teacher surveys have been used to gather evidence about the impact of teacher workshops. These have used both closed questions (i.e. quantitative data) and open-ended responses (qualitative data, which has been coded). In-depth qualitative methods have been used in case studies to gather video evidence of teachers and pupils. Case studies will be presented and sorted by the EU-UNAWE evaluation framework's cognitive skills.

4.1 Motivation

The domain of motivation refers to the following objectives: enjoyment, inspiration, curiosity and tenacity. The type of evidence that would be acceptable for this domain comes from teachers who experienced a positive association with Astronomy workshops and children behaviour:

- Children are completing the tasks with pleasure
- Children are engaged in the activity
- Children react with diligence towards the proposed activities
- Children demonstrate attention
- Children apply perseverance/tenacity
- Children manifest inquisitiveness
- Children introduce some complex questions

Motivation Case Study: Evaluation with children at Circolo didattico di Zafferana school in Etnea, Italy. Children were asked to write essays after taking part in UNAWE activities for 2 weeks. The EU UNAWE Italy National project managers had ensured that content was linked to a topic the children were already studying in class; thus, the Year 2 children received constellation stories linked to American Indians. The Year 3 children had narratives tying in with Ulysses. Planning to respect the existing curriculum units makes it more likely that activities will be used again. Following the activities, children were asked to write freely about the night sky and its mythologies and phenomena. Using an observation paradigm, recorded children's responses to a variety of activities include the following:

• Children are performing the tasks with pleasure, writing spontaneity texts and drawing.

• Children react with diligence towards the proposed activities, and they write texts longer than requested or write more essays than expected.

• Children introduce some complex questions. Many of the texts relate to lives of stars and the existence of extra-terrestrial life.

Motivation: Evaluation of teachers training workshop at House of Astronomy, Heidelberg, 2012. The teacher survey, carried out after a teacher training session with 78 teachers presents evidence that teachers had positive associations with parts of the course. The workshop facilitators, (EU-UNAWE Germany

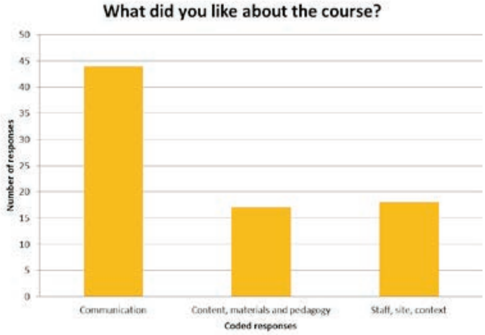

Figure 3. Overall results of teachers training workshop at House of Astronomy, Heidelberg, 2012

National Project Managers), were particularly highly regarded due to their enthusiastic presentation skills.

4.2 Scientific Skills

The Scientific Skills domain refers to developing scientific thinking and problem solving techniques such as observation, identification, classification, making interconnections, changing perspective, and communication. Evidence for this domain has been gathered from teachers in the form of self-report in questionnaires, teacher training workshop observations using video, and teacher interviews. Evidence has been gathered from children in the form of discussion and group tasks and class observation following teachers attending training workshops.

The types of evidence that would demonstrate scientific skill development are as follows:

- Correct use of vocabulary or gestures to name objects and phenomena observed in the sky
- Grouping objects/phenomena to indicate developing understanding of astronomy concepts
- Making conjectures available to be contrasted
- Developing some experiences related to the hypothesis
- Linking new information with existing concepts of the same or different areas
- Removing previous points of view according to new inputs
- Sharing with others their new knowledge

Scientific Skills: Evaluation of children at Brownhall Primary School in Dumfries, Scotland, 2013

Teachers who attended the teacher-training workshop in Dumfries were contacted and asked permission to visit their classroom and observe a session related to the workshop content. One teacher was selected for a visit two weeks after the teacher-training workshop. Parental consent forms were distributed and collected for permission. The session was recorded, and children were interviewed using a semi-structured interview technique which covered the EU-UNAWE domain framework: motivation, skills, knowledge, intercultural awareness, and legacy. A class from Brownhall Primary School in Dumfries was observed taking part in an activity inspired by the workshop (Figure 4).

4.3 Astronomy Knowledge

EU-UNAWE programmes aimed to develop teacher and pupil knowledge about astronomy through observing, exploring, and discovering:

- The Sun, its relative position, sunlight (shadows), day/night cycle, time zones, the seasons, the Moon, the Earth as a planet, aware-


Figure 4. The Nine-year-old student at Brownhall Primary School demonstrating communication skills through explaining why people in different countries are awake at different times. He turns the earth in the correct direction, holding out his left hand to represent the sun shining on different countries at different times. He identified where Dumfries is located and referred to the Pole star, which is fixed to the classroom wall. This interview provides evidence for cognitive skills, including knowledge and intercultural awareness, although scientific communication skills comprise the main focus.

ness of water, the Earth's atmosphere, and sunlight's roles in the development of life on Earth, solar and lunar eclipses, etc.

- The Solar System: planet characteristics and movements, dwarf planets, asteroids, comets, etc.
- The Stars in the night sky, the constellations, orientation, the life-cycle of stars, the formation of stars and planets, etc.
- Our place in the Milky Way, family of galaxies, etc.
- Current developments in astronomy
- Magnetic fields (compass, northern lights, etc.)

Knowledge: EU-UNAWE Teacher Training Workshop in Barcelona, Spain. The evaluation (Figure 5) of the EU-UNAWE teacher training workshop was used to demonstrate improvement; clearly the effectiveness of workshops improved in response to teacher comment (N=33) , and 88% of teachers consider that they learnt new content.

4.4 Intercultural Awareness

The domain of intercultural awareness was defined by development in being able to value different cultural perspectives, recognising different physical perspectives, and valuing inclusive education. Children must be able to work individually and in teams. Teacher self-report and workshop observation have

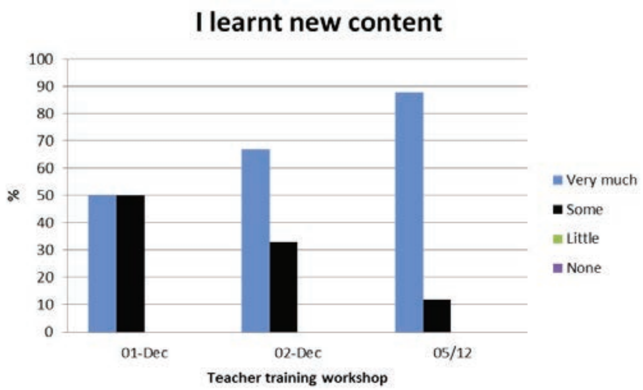

Figure 4. Results of the content evaluation of the workshop.

allowed data collection for this aspect. For children, evidence can be seen in the form of:

- Demonstrating awareness of different cultures
- Ability to observe and explain differences in phenomena in different countries
- Statements of future activity with regards to astronomy
- Act in an appropriate way in a frame of diversity

Intercultural Awareness: Evidence of children's participation. A number of links have been and continue to be facilitated through Skype and connections made possible by the EU-UNAWE programme. The video available at http://vimeo.com/52849722 shows children from Nompumelolo Primary in East London, South Africa, interacting with children from Morskring Primary in Leiden, The Netherlands. The project was conducted for one month, focusing on moon phases and seasons. Learners observed the different moon phases from the 21st of May to the 21st of June. During this month, the learners watched the night skies and recorded their observations on a moon calendar. This information was reinforced through various activities about the moon in

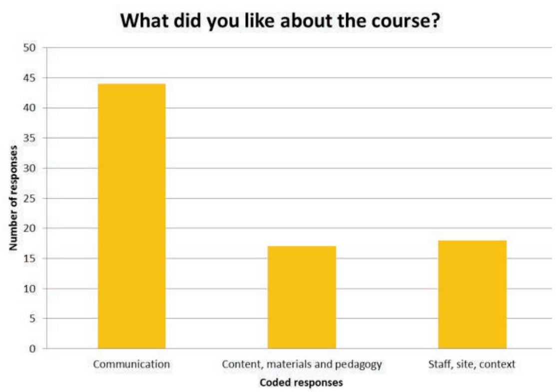

Figure 6. Intercultural awareness results from activity between EU-UNAWE Italy and South Africa.

the classroom. The learners made moon phase flipbooks illustrating moon craters and their weight on the moon.

Intercultural Awareness: Activity between EU-UNAWE Italy and South Africa. Italian EU-UNAWE National Project Managers travelled to South Africa during Science Week 2012 (July- August). They organised activities at 5 schools, seeing approx. 600 pupils and 20 educators. South African astronomer, Shazrene Mohamed, offered a discussion session with pupils to initiate interest in the topic. Pupils then saw a planetarium show (the first time they had seen this). Italian teachers used puppets to enhance student understanding of the constellations Orion, Crux, and Scorpio. A live link took place between South African teachers and Zafferana Etnea school in Sicily, Italy. Teachers were surveyed regarding children's ability following the exchange, and the teacher reports evidence that learners developed cultural awareness (figure 6).

The direct exchange projects are in addition to teaching which explicitly shares different cultural approaches to, for example, explaining the seasons. The project resources, which encourage appreciation of narrative in early astronomy experience, have been produced and translated, such as the Earth Ball and activity book.

4.5 Legacy

Legacy refers to the continued programme impact beyond its completion in December 2013. For teachers, this includes embedding astronomy learning from UNAWE into the curriculum and continuing to teach using resources from EU-UNAWE. They may share their knowledge with other teachers in school-based continuing professional development courses and change long-term planning. For children, this includes their aspirations for studying astronomy and assimilation of learning as outlined in the domains listed above. In addition to the legacy in terms of teacher and pupil learning, what are the long-term benefits of this programme? This was assessed through asking teachers and pupils about their long-term intentions regarding astronomy and what they had learnt through participating in EU UNAWE programmes.

Legacy: Evaluation of United Kingdom teacher training in November 2011. In a survey of 48 teachers, teachers were asked to state what they would do following the teacher-training workshop. The results were generally positive, e.g. the following examples:

Initial Action Plan – As a result of this training I will: "*Endeavour to deliver the programme to my own P6 class within our World Around Us planning/teaching. Disseminate today's programme to my other 3-year group colleagues in P6 and possibly to the P7 year group. Explore resources indicated to us today and try to secure funding for those requiring purchases.*"

Follow up: Have you ever had a chance to talk to your colleagues about EU-UNAWE to disseminate what you have learned? "*I disseminated some of the materials at a staff meeting. I have also incorporated the materials into a* *unit called Razzle Dazzle – all based on light, planets, constellations etc. and have shared it with two colleagues from other schools who have also used it.*"

Another teacher in Scotland at the senior management level stated the intention to build the materials into existing astronomy curriculum areas. She said, "We are aiming to develop experiences and outcomes (Scottish curriculum Es and Os) which will take learning from the primary curriculum into the secondary curriculum in biology, chemistry, and physics."

It is therefore recommended that teachers attend the workshop in pairs if possible, with one teacher a junior, enthusiastic member of staff, and the other being a more advanced member of staff from the same institution. In this way, the desire to take on ideas will be facilitated by the ability to overcome bureaucratic barriers which may arise. In addition, it would be helpful to ask teachers to bring copies of the short, medium, and long-term planning so that they can share and pinpoint exactly where the opportunities for modification of existing plans are. This will also help highlight any paucity in potential for change, which needs to be addressed institutionally.

4.6 Discussion

The EU-UNAWE project was assessed using the evaluation framework, according to 5 domains, as described above. However, this framework was devised during the project lifetime, and it would be beneficial to move on from this programme by using the existing framework as a starting point for future projects. Its goals are clear, and the literature supports the fact that it is an ambitious task to bring together different learning approaches and philosophies under one common framework. In reality, local adaptation has been the solution to allow assimilation of evidence coherently, despite different philosophies.

This section will return to the original operational objectives and show where existing activities and resources meet the initial objectives of EU-UNAWE. Examples are drawn from both national programmes and the wider international network, which has expanded throughout the programme timescale.

Table 10. Overview of evaluation numbers for the operational objectives.

Operational Objectives	**Evaluation Numbers & Additional Information**
Train and empower primary school teachers in 6 countries to include astronomy and space topics in the classroom	Number of teacher trained: 2 373
Develop and translate hands-on material, where appropriate, emphasising EU and SA science and technology	Number of Resources produced and distributed: > 11 000 (see table 7)

Provide a network for exchange of expertise and material between educators - Lay the groundwork for expansion of the programme throughout the EU, Associated Countries and ICP Countries.	Number of Universe Awareness National Nodes: 61 National Programmes, mainly from EU, Associated and ICP countries. Complete list available here: http://www.unawe.org/network/national/
Act as a showcase for EU and SA astronomy/space and related technologies, by disseminating the products among very young children, their teachers, and families.	Number of exchange activities between EU and South Africa: 2 Space Scoop news service is unique in providing information about innovations in astronomy and space, which are suitable for children aged 8 and above, their teachers, and families both in Europe and South Africa.
Use astronomy/space products to stimulate awareness and strengthen public support for EU and SA space science research and technology.	Number of activities engaging general public: 15 Whilst the focus of this evaluation has been on teachers and children, members of the public have also seen UNAWE resources at some festivals attended by the EU-UNAWE during the project lifetime. For example: • EU Festival of Europe, Brussels, Belgium http://www.festivaldeuropa.eu/en • "The Dreamgazer" children's astronomy story film premiered at a Leiden Film Festival, The Netherlands http://www.nachtvankunstenkennis.nl/ • Festival Nauke, Belgrade http://www.festivalnauke.org/ • SciFest, South Africa http://www.scifest.org.za/ • BBC Stargazing live http://www.bbc.co.uk/programmes/b019h4g8

Stimulate the next generation of EU and SA engineers and scientists, particularly girls.	Number of activities targeted to girls: 10 EU-UNAWE activities have contributed to some specific initiatives to inspire girls to study science and engineering at advanced levels, such as Green Light for Girls http://greenlightforgirls.org/. EU-UNAWE took part in an event in Brussels, Belgium in October 2012, where 300 girls participated in interactive workshops and the UNAWE activity: designing an alien life form.
Contribute to the integration of disadvantaged communities in participating countries.	Number of activities engaging disadvantaged communities: 33 It is clear that there is an aspiration to work with disadvantaged communities, both within the partner countries and internationally. International outreach has focused on disadvantaged communities. For example: • Timor-Leste; see project report: http://www.unawe.org/static/archives/reports/pdf/TL_VT2012_project_EN.pdf • Spain (Universitat Politècnica de Catalunya - UPC) offered teacher training programmes and summer schools, which included specific training for pupils with special need • Northern Ireland initial project team meeting (2004) highlights the issues facing disadvantaged communities in their context.
Strengthen collaboration between EU and SA over mutually beneficial scientific, technological, educational, and social topics.	Number of exchange activities between EU and South Africa: 2 Additional links between schools in Leiden, The Netherlands, and East London, South Africa as described. South African pupils visited the House of Astronomy, Heidelberg, Germany

Provide significant added value for Europe's expenditure on astronomy and space sciences for a modest incremental cost.	Number of resources produced for all the EU-UNAWE consortium: 11 000 (mainly Earth balls and Universe in a Box kit)
Pooling complementary expertise and partner resources creates a project whose whole is greater than the sum of its parts.	Number of resources produced for all the EU-UNAWE consortium: 11 000 (mainly Earth balls and Universe in a Box kit)

As demonstrated above, the main goals of the EU-UNAWE project were accomplished. With support of the funding from the European Union more than 10 0000 of new inquiry-based learning educational resources and training of more than 2,300 teachers, reaching over 81 000 pupils through direct and indirect activities. Besides the accomplishments of the EU-UNAWE in training teachers and developing general educational resources, highlights of the projects were as follows:

- The development and distribution of 10,000 EU-UNAWE Earth balls
- The development and distribution of 1,000 Universe in a Box astronomy kits for primary school teachers
- The creation of Space Scoop: astronomy and space news for children
- UNAWE awarded the prestigious 2011 *Science Magazine* Science Prize for Online Resources in Education (Ödman-Govender & Kelleghan 2011).

The European Union's External Review Report states: *"The project has achieved all its objectives in an excellent way. In addition, there is a large number of spinoff activities initiated by the consortium that, although not mentioned in the Description of Work, are extremely relevant to the project. The teacher training part of the EUNAWE exceeded its quantitative goals by a wide margin. The project has resulted in a vast amount of educational resources on the web, organised in an excellent manner. Most of the educational output resources have been evaluated and tested in practice for suitability for the target groups (young children and their teachers). They can lay the foundation for deeper understanding of astronomy (and hence science in general), both through creating factual knowledge and the building of a conceptual framework. [...]The project has fully achieved its objectives and technical goals for the period or has even exceeded expectations.*"

4.7 Recommendations

Based on the experience of implementing and evaluating the EU-UNAWE project, we here present several recommendations that should be taken into account in designing future UNAWE activities as well as other similar science education activities for young students. It is recommended that:

- Teachers should be invited to teacher training workshops in pairs, ideally with one senior and one junior member of staff, in order to maximise the ability of each school to embed new materials at strategic and operational levels.

• Teachers should be asked to bring copies of their short, medium, and long-term planning to ensure that part of the day involves sharing with other schools where they can fit the new information into timetables. The purposes of this are twofold; the first is for the institution to realistically plan. The second is for comparison with other organisations to bring a flexible approach to considering other ways of organising the curriculum.

• Existing educational resources should be peer reviewed using IAU astroEDU (or similar) in order to assess and improve quality.

• The infrastructure, which has facilitated resource dissemination and translation, should continue.

• Science and Education Festivals are excellent formats for engendering public support.

• The development of a template for longitudinal evaluation is needed in order to assess the long-term impact of UNAWE. This is particularly important for evaluating the success in accomplishing the non-cognitive UNAWE goals, such as sustaining motivation, encouraging tolerance and respect and stimulating a sense of world citizenship.

• The preparation of a set of guidelines and instructions for setting up and testing Skype international video exchanges would be useful for interested schools.

• Produce resources for young children in their native languages.

• Experts in the professional evaluation of science education programmes should be included in the team from the start and provide input to the design of the project.

5. Legacy, Future, and Sustainability of Universe Awareness

After the EU-UNAWE project formally concluded in December 2013, several follow-up activities were carried out In the first half of 2014, a successful crowdfunding campaign was initiated to distribute the UNAWE Universe in a Box educational resource to educators throughout the world. In September 2014, a Creative Industries Grant from the Netherlands research funding agency, NWO, was acquired to develop video instruction lessons for some of the Universe in a Box activities and by January 2015 Space Scoop had published more than 555 news stories for children.

Furthermore in November 2014, the European Union awarded 2 million Euros in support of a follow-up project, EU Space Awareness (EUSPACE-AWE). This project that will use the excitement of space to attract young people to science and technology and stimulate European and global citizenship. EU-

SPACE-AWE will build on EU-Universe Awareness. The project will show children and teenagers the opportunities offered by space science and engineering and inspire primary-school children when their curiosity is high and their value systems are being formed. EUSPACE-AWE, a 3-year project, will start in March 2015 with 10 partner organisations and 15 network nodes in 17 European countries and global dissemination by the IAU Office of Astronomy for Development in South Africa. Activities will include teacher training, the development and distribution of educational resources, and a high-impact event for teachers and policymakers at the European Parliament. EUSPACE-AWE will exploit extensive European school networks and science museums to reach teachers, schools, and the general public and will work closely with the European Space Agency. Particular attention will be paid to stimulating interest amongst girls and ethnic minorities, reaching children in underprivileged communities where most talent is wasted. A special EUSPACE-AWE toolkit showcasing the history and accomplishments of Islamic science and technology will target children from the Turkish and North African migrant communities. In this chapter we have attempted to demonstrate the large potential societal benefits that can be provided by an educational programmes such as UNAWE, that exploit cutting edge research and researchers to inspire young children. The EUSPACE-AWE project will facilitate limited continuation of UNAWE activities for an additional three years. We suggest that the experience of EU-UNAWE shows that the provision of long-term structural funding for UNAWE and its infrastructure would be highly cost effective and of considerable benefit to society.

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