Design, implementation and evaluation of transnational collaborative programmes in astronomy education and public outreach

Rodrigues Dos Santos Russ, P.M.

III.2

Design, Development, and Impact of Physical Resources for Science Education

Physical educational resources provide a useful supplement for educators to demonstrate abstract or complex concepts. There has been considerable research on the benefits of resources based on inquiry-based learning for scientific and technical subjects. Universe in a Box is one such astronomy kit developed as part of the Universe Awareness (UNAWE) programme coordinated by Leiden University. It is designed to explain difficult and abstract astronomical concepts to young children (4 to 10 years old) by providing practical activities as well as the materials and models required to do them. The innovative approach to a collaborative development across the UNAWE network has made Universe in a Box the first international astronomy education resource produced and used globally. We consider the advantages and disadvantages of different models for the production and distribution of global science education kits. The preliminary social and educational impact and potential of such an educational kit are also presented and discussed.

Publication

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1. Introduction

An educational kit is a product that can be used by teachers or their pupils to explain a concept, idea or theme. Educational kits cover a variety of subjects. This article will focus on practical, hands-on education kits covering scientific topics. Practical activities are a necessary element of promoting the understanding of scientific principles for children of all ages. The importance of practical activities was highlighted in a World Bank report, which stated that "practical work in science education increases comprehension of scientific principles and their application in the real world" (Musar, 1993). It is much easier for children to understand phenomena such as "the seasons" with a visual three-dimensional model rather than a two-dimensional diagram in a book or on the blackboard.

2. Educational Kits in Astronomy

Astronomy is an engaging theme for educational kits because children have a natural fascination with the night sky and because astronomy can be used as an umbrella for a wide range of topics, both scientific and cultural.

In 2010, a Relevance of Science Education (ROSE) survey asked school pupils from countries all around the world questions about science and their interest in it (Sjøberg & Schreiner, 2010). Much of the study focussed on finding ways to motivate students to follow science subjects for longer periods. The researchers found many differences in attitudes between developing and developed countries and between boys and girls. Generally, students from developing countries appeared to find science more interesting and wanted to study more of it, whereas students from developed countries were less enthusiastic about science. Boys seemed to like studying explosive chemicals more than girls, whose interest lay more in body and health than boys. One surprising outcome was that, overall, boys and girls from 40 countries surveyed find space the most interesting scientific topic (particularly, questions about "The possibility of life outside Earth")(Sjøberg & Schreiner, 2010).

The International Astronomical Union (IAU) has developed and ratified a strategic plan called "Astronomy for Development 2011 - 2020" (Miley et al., 2012), which demonstrates that astronomy can be a unique tool for global capacity building and highlights the fact that astronomy provides an inspirational gateway to technology, science, and culture. The rationale of this ambitious document is that, because astronomy links science and technology with inspiration and excitement, it has the potential to enable technological capacity building and education, thereby as well as be a tool to furthering sustainable development throughout the world.

As part of an initial investigation for the Universe Awareness project in 2012, Ramchandani (2012) researched astronomy kits that were available at the time. She found that most of these astronomy kits were restricted to the Solar System and did not cover the broad range of modern astronomy. Also,

because they were usually heavily linked to local curricula, most available astronomy kits were unsuitable for a wide global audience.

Many primary school teachers experience science as a difficult subject and are, therefore, reluctant to teach it in their classes. Universe in a Box was developed to be a high-quality, easy-to-use astronomy resource that would help combat a teacher's fear. The following section describes the various stages of development of Universe in a Box.

3. Design of a Global Astronomy Educational Kit

3.1 Initial concept

Universe in a Box was an original concept of the House of Astronomy in Germany (www.haus-der-astronomie.de). It was developed under the MINT Box program for STEM education, supported by a grant from the Baden-Württemberg Foundation. Development of the box began in 2010, and the prototype was tested during seven pilot projects in February 2011 (Bwstiftung, 2014).

The authors developed the toolkit based on several pedagogical resources (Goswami (2008), Nobes et al. (2003) and Pauen (1996)) in order to ensure educational goals and activities were suitable for the age groups recommended. Universe in a Box has been designed as a didactic tool for teachers with inquiry-based learning (Bell, Urhahne, Schanze, & Ploetzner, 2010) for primary education students. The material offers the opportunity to work out the answers to questions on astronomy. It encourages hands-on learning, discussing, drawing conclusions, and presentation. The materials required for the activities are, with a few exceptions, low cost and also easy to hand-make.

Universe in a Box helps teachers in a variety of ways. Its main goal is to assist teachers overcome the hurdle of initial preparation for teaching astronomical topics by choosing appropriate focus areas and providing appropriate learning content and materials. The activities are designed to help make the connection between astronomy and other fields of science, art, religion, and culture and can be used by both 'beginner' and 'advanced' teachers.

Universe in a Box has a modular design and comes with three modules: The Earth-Moon-Sun System, The Planets, and The World of Constellations. The central theme starts by focusing on a topic that children are familiar with: the Earth. Questions include the following: (a) Why do we have day and night? (b) What shape is the earth? and (c) How can I tell? It then shifts on to the sun and the concepts of year and seasons come into play. Then it shifts to the moon: (a) Why does the moon change its form? (b) What is a month? (c) How long is a lunar day? and (d) What can we learn from the shapes of the moon craters? It then emphasises that planet Earth is not just a planet, but a special one, and asks questions such as Can we live on another planet? and What do we need to live? Finally, it introduces stars and identifies constellations.

Questions such as Is the life of a star eternal? and Do they all have the same colour? are addressed and answered.

Either individual activities or entire modules can be used in the classroom, both with large and small groups. Add-on modules on the life of a star, galaxies, and the "Earth-Human" system are currently in development. Educators are encouraged to customize the box with additional activities and material of their own. Apart from the relevant background and activity descriptions, the activity handbook also offers ideas for teaching astronomy integrated with other disciplines, guidance on further experimentation, and photocopy-friendly craft templates to extend and apply the newly learned knowledge.

Universe in a Box is also a product that resonates with Article 29 (1) of the Convention on the Rights of the Child, U.N. Doc. CRC/GC/2001/1 (2001), which states that the education of the child should be directed to the following:

1. The development of the child's personality, talents, and mental and physical abilities to their fullest potential;
2. The development of respect for human rights and fundamental freedoms and for the principles enshrined in the Charter of the United Nations;
3. The development of respect for the child's parents, his or her own cultural identity, language and values, for the national values of the country in which the child is living, the country from which he or she may originate, and for civilizations different from his or her own;
4. (d) The preparation of the child for responsible life in a free society, in the spirit of understanding, peace, tolerance, equality of sexes, and friendship among all peoples, ethnic, national and religious groups, and persons of indigenous origin;
5. (e) The development of respect for the natural environment.

3.2 Mint Box & Educational Development

Table 1 details the design elements including the educational features of the original prototype for Universe in a Box, the Mint Box (based on Fisher 2011). Eighteen MINT boxes were assembled, 15 of which were distributed to schools; another 10 DIY (Do-It-Yourself) kits were also given to schools. The

MINT team implemented the box through several workshops, reaching a total of 307 children and 44 teachers.

Table 1. Design elements of the original prototype for Universe in a Box.

Educational Goals	Promotion of numerous primary education competencies through astronomical themes (Baxter, 1995). Linking astronomical topics with other subjects (mathematics, art, religion, science fiction etc.) to support interdisciplinary learning and sustainability. (Saunders, Brake, Griffiths, & Thornton. 2004). Awareness of children to respect others' cultures, the origin of life, and to protect the earth by the realization that we are all inhabitants of a small, blue planet Earth. (Arends, 2015).
Audience	Use in both elementary school (4- to 10-year-old children) and extracurricular activities at science centres, observatories, planetariums, museums, outreach programs, amateur astronomy centres, etc. Ideal student-to-teacher ratio of 1:20.
Educational Approach	Pre-selection of topics forming three modules: Earth-Moon-Sun System, The Planets, and The World of Constellations. The topics follow a didactic order, and activities have an interdisciplinary / cultural focus. Inquiry-based learning educational activities.

Flexible Educational Design	Educational models provided for teaching. Add-on modules on galaxies, stars, and the Earth-Human system currently in development. A complete description of the materials and the activities, Astronomy background information on the science behind the activity. Suggestions for interdisciplinary activities. Suggestions for further reading and experimentation. Guide in loose-leaf folder format for customization and easy updating. Photocopy-friendly craft templates. Educators can use the box in a modular fashion depending on topic. Educators can customize with additional activities and material. Educational materials are low-cost and can be easily reproduced or purchased Teacher training. Teachers with no experience in astronomy benefit from a teacher training workshop.

Training feedback was positive and both teachers and students were enthusiastic about the workshops. Many participants felt more confident after a first introduction to the subject. Teachers with no experience in astronomy benefitted particularly from an associated teacher-training workshop. The feedback led to the consolidation of the modules and respective materials (Table 2).

Table 2. Educational activities sorted by modules including the materials and the corresponding activities, which are covered in the handbook.

Materials	Educational Activities
Module 1: Earth-Moon-Sun	
Globe Three small figures Patafix Small ship Bulb holder Bulb Styrofoam moon Moon and Earth masks	Characteristics of the moon, moon distance, lunar laboratory, lunar landscape games, reflected light, 3D visualization of the phases of the moon, moon phase box, moon phases, mosaic pictures of the moon from other countries and cultures, pictures and stories about the moon, mini research project: The lunar orbit Round Earth, dialogue between children at opposite ends of the Earth, Earth mosaic, our planet, day and night, seasons, tilted Earth's axis Sun's Apparent Size I, Apparent Size II, Invisible Light, Path of the sun across the sky, sun shade, construction of a sundial, solar surface convection, mini research project: Sun: Solar rotation
Module 2: The Planets	
2m string Planetary system of wooden balls Card game Laminated pictures of the planets Origami rocket	Card game on the sun and planets, model of our solar system , when can I see planets, ellipses, construction of a planetary path, construction of rockets
Module 3: The World of Constellations	

Zodiac band Constellation projector with time cards Images of the zodiac Zodiac book 10 stars Blue cloth Planisphere (handmade) Planisphere (sourced)	Zodiac band with planets and constellations, visibility of the constellations, function of a Planisphere, the constellation Cassiopeia, constellations of the year, constellation viewer

3.3 EU Universe Awareness: Consolidation

Figure 1. Universe in a Box content.

The MINT box was identified by the EU Universe Awareness project (Schrier, Nijman, & Russo, 2012) as a potential global product with local reach, one that could be globally standardised to an extent to gain economies of scale and scope but localised to meet local requirements. The "*glocalisation*" of educational resources has been discussed by Willems and Bossu (2012). Universe in a Box was considered suitable because its content fits with the required educational curricula of many countries and because the activity book and materials come in a format that is easy to localise and reproduce. Feedback was gathered from educational experts and astronomers on ways to further improve the kit. Handbook content and layout were changed, and the materi-

als for several of the components were changed in order to make them more durable and better quality (Ramchandani, 2012).

3.5 Prototype

Four companies were contacted to request quotations for the production of Universe in a Box. Curion Education Pvt. Ltd. was selected to be the main producer of the international version. The production and shipping of 50 prototype Universe in a Boxes (Figure 1) to 30 countries was then arranged. These were selected from 100 requests from schools received via the UNAWE website and favoured requests from those most likely to maintain future involvement in production, distribution, and/or educational input. Proposed production costs were 30 EUR, although this increased to 45 EUR per box due to the small scale of production and various improvements to materials. On average, each box shipping cost was 45 EUR.

All 50 prototypes were well-received. Educators from 45 countries found most of the materials attractive and easy to implement for children between 4 and 10 years old. Handbook activities were easily understood, with the guide being described as "*rich*" and "*well-explained*", although more translations were requested (French, Arabic, and Hindi translations were suggested). The evaluation from an educator training session in South Africa seemed to sum up the overall feedback when session administrators stated that "*educators have concluded that Universe in a Box will have a significant impact on their teaching of astronomy in the classroom and will enable their learners to apply their content knowledge using various activities in the toolkit*". They further suggested that the box will *"stimulate interest in space science"*. By August 2013, the first large-scale production (1000 boxes) of the English international version of Universe in a Box was commissioned. Feedback from users of the 50 prototypes was used to improve the production version Universe in a Box.

4. Production and Distribution

There are several approaches to supplying and distributing educational equipment widely (Musar, 1993):

- Production by teachers and students
- Establishing central production units
- Central development and assembly of kits
- Decentralised development and production
- A combined approach

Although teachers and students know well what is needed in their special environments, quality can be better ensured by a wider approach that allows input from external specialists. Some countries have central units for production of teaching aids (including equipment for science education), often as part of the responsible Ministry or a not-for-profit organisation. There is a risk, however, that when a unitary system produces equipment for the whole national education system, monopolisation costs and political issues will arise. Buying certain materials in stock (on the domestic or international market) and repackaging them in small lots exploits economies of scale and is a potential attraction of the central development and assembly of such kits.

However, this requires significant infrastructure or initial effort, and shipping costs are lowest when production is closer to demand. Global shipping can cost more than the products themselves.

In general, a hybrid approach is optimum and allows for development of locally relevant, high quality resources in economically efficient ways. After careful deliberation, it was decided to produce Universe in a Box using the hybrid approach.

Universe in a Box is only one of several educational resources being developed by the UNAWE project, and one of the main aims when considering how to proceed with Universe in a Box was to create a framework through which future resources generally can also be distributed and improved.

The production and distribution of Universe in a Box is evolving towards a regional production hub model to take advantage of benefits discussed later in this report, with a substantial fraction of boxes being produced and distributed from a central point.

4.1 Centralised production

Production costs can be reduced by scaled-up production. One of the benefits of centralised production is that, by producing a greater quantity, the cost per unit decreases. Centralised production also assures an element of consistency and quality control of the resource.

In January 2014, the UNAWE International Office (based at Leiden University) commissioned the production of 1000 International English versions of Universe in a Box. These were produced by Curion Education, the same company who produced the 50 prototypes. These boxes were shipped to Leiden, the Netherlands, where the International Office assumed responsibility for the distribution.

Drawbacks of centralised production are that it limits localisation opportunities. All boxes have to be identical. For example, all 1000 boxes had the English handbook, and substituting this for another language could only be done at additional cost. Also, because the socket for the included lamp stand had a European two-pin plug, adjustments needed to be made for use in many countries (examples: the UK or USA).

4.2 Localised production

An innovative aspect of the Universe in a Box is the Do-It-Yourself Guide (Ramchandani, 2014). This guide gives instructions on how to replicate the box from locally sourced components as an alternative to ordering from the

International UNAWE Office. Localised production of educational resources has the following benefits:

- Affordable and locally suitable costs
- Better availability of spare parts
- Higher relevance to curriculum (and flexible adaptation)
- Higher local content (including translations of material)
- Direct marketing
- Savings on distribution costs

UNAWE national coordinators Ivo Dzhokin (from Bulgaria) and Arif Bayirli (from Turkey) used the DIY version of the Universe in a Box handbook to produce the kit locally. The Bulgarian kit was constructed using cardboard and Styrofoam balls. It also included an additional activity on constellations involving constructing models of Ursa Major constellation from small Styrofoam balls and wooden skewers. Dzhokin presented the original kit (ordered and shipped from UNAWE International Office) at the annual Bulgarian Astroparty and donated 17 locally produced versions of the kits to schools participating in this event. During the astronomy event, he explained several of the activities to teachers in Bulgarian.

All teachers in this session gave good feedback and showed great interest in the UNAWE-Bulgaria project in general. Articles were published in local and national media, as well as information sent to the Ministry of Education and Science. Dzhokin's session in Bulgaria had 14 teacher participants, 46 students, and nine guests.

In Turkey, Bayirli and colleagues built two boxes using the DIY guide. They used the opportunity of a teacher training workshop in a 2014 conference called "Best Practices in Education" in Istanbul to put together and promote the idea of the DIY kits. Due to customs issues and costs, they preferred to construct their own Universe in a Box. Bayirli also pointed out that "building the box familiarises the users with the materials", aiming to give workshop participants the message that they can easily "go and get the materials provided from the UNAWE website and print them on a cardboard and go to a local craft store and gather the materials you [they] need and like!" He estimated that producing the box in Turkey costs almost one-fourth of ordering directly from the UNAWE International Office (which covers shipping costs as well).

The DIY guide and the print package were translated into Turkish and are now available on the UNAWE-Turkey website for download (http://www.evrenianlayalim.org/p/bir-kutu-evren.html). Translation of the Activity Guide into Turkish is an ongoing process. Some items from the DIY guide were not easily available in the local market, so several changes and alternatives were implemented; these were then suggested in the Turkish translation of the DIY guide. The model of the solar system proved particularly difficult to locate. The translated Turkish version of the DIY guide has been distributed to 100 teachers during teacher training events, which are the main part of UNAWE-Turkey's astronomy activities. Overall Bayirli says they prefer to order the box from the International Office despite the difference in price because

most UNAWE members in Turkey are voluntary and building the DIY version is quite time-consuming. He has said, "*We are planning to promote building the box or if they can afford it to buy, just purchase from the UNAWE; it is much more manageable*".

4.3 Centralised distribution model (through the International UNAWE Office)

As mentioned in the Production section, the first large-scale production of Universe in a Box (the 1000 boxes produced by Curion) was stored and distributed from the International UNAWE Office at Leiden University. These boxes were distributed globally to more than 40 countries.

Shipping costs of centralised distribution are relatively high (see Table 1 for accurate shipping cost estimates from August 2014 from www.post.nl/tarieven/), and it requires one central distributor.

Table 1. Shipping costs for Universe in a Box

Destinations (From Leiden, Netherlands)	Costs of sending one unit by regular mail (49 x 39 x 25 cm weight 8 kg)
Netherlands	6.95
Germany	25.00
Portugal	31.00
Iceland	32.30
Nepal	58.30
Australia	58.30

Centralised distribution allowed the implementation of a BuyOne-DonateOne scheme for distribution of Universe in a Box. Under this scheme, a school or organisation that can afford to do so, pay the costs of production and shipping for the equivalent of two boxes, though they only receive one. The other box is sent to a school or organisation in an underprivileged community that otherwise could not afford it. This scheme had limited success; in total only 17 boxes were donated this way. It was this lack of uptake that persuaded us to undertake a Kickstarter crowdfunding campaign (see Crowdfunding campaign section).

4.4 Regional distribution model

Regional distribution can be combined with centralised production or it can be coupled with regional production. Regional production means that the pricing of the resource is more consistent with regional prices, thereby ensuring that the resource is more affordable for the regional market. Also, regional production contributes to the economic development of the region. Furthermore, by reducing the distribution costs, production of the kits in the region or shipping them in bulk to a central regional node minimises one of the major contributions to the cost of the kits.

Regional distribution requires several people in different places and one central coordinator to ensure consistent quality of production and to provide

support where necessary. Therefore, it is proposed to optimise the future production and distribution of the kits. The boxes should be produced at regional nodes and distributed from each node. This would replace the current model where boxes are produced in India and then shipped to where they are required. The individuals or organisations who take on the role of producing and distributing the kits will become 'localisation, production, and development' partners of Universe in a Box. These partners will be trained to use the box and trained in how to train others in its use. They will be given a DIY Universe in a Box kit with additional resources to enable them to source and reproduce Universe in a Box. These hubs will train local users in the resource and be responsible for distributing the boxes they have produced to these newly trained and enthusiastic local users.

The process of finding localisation, production, and distribution partners is ongoing as these will enable Universe in a Box to develop its distribution nodes on a regional basis. The organisation must also coordinate the process of becoming a partner (e.g., peer review, setting price, etc.). Country/region-specific information should be created concerning business plans (and their implementations) and advice on how to obtain funding. The International UNAWE Office should also assist in the actual production and distribution setup where necessary as well as provide seed loans for prototyping.

5. Crowdfunding campaign

In May 2014, the UNAWE International Office undertook a successful Kickstarter crowdfunding campaign and raised more than €17,000 to send Universe in a Box around the world to underprivileged communities and to produce online training videos. The following sections describe the steps involved in developing and carrying out the campaign as well as a few things learned from organising a crowdfunding project.

5.1 Development

An important goal of the Universe Awareness team was to share the astronomy education resources with underprivileged communities, but by early 2014, the purchase of boxes under BuyOne-DonateOne had been less successful than hoped. The use of a crowdfunding campaign was an alternative method to support sharing the Universe in a Box kits and increasing their internation-

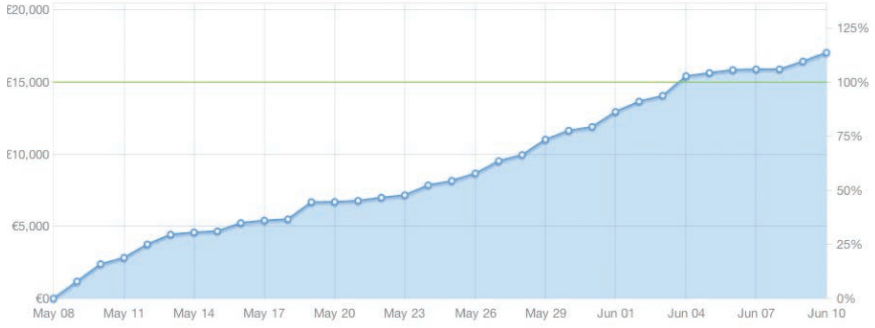

Figure 2. Evolution of the donations during the campaign period

al recognition. The plan for this campaign was to distribute boxes as 'rewards' for backers of the project as well as raise the funds necessary to send a number of boxes to underprivileged communities who otherwise could not afford them. The large publicity and campaign effort that must accompany crowdfunding raises international awareness of projects and products. The campaign used the equivalent of two months of full-time work by a UNAWE employee (before and during the campaign) as well as €800 to produce a campaign video (mostly rental of equipment and specialists). After careful budgeting and planning, the financial target for the campaign was set at €15,000. This was to cover the costs of distributing 160 Universe in a Box kits around the world to underprivileged communities and the costs of producing online training videos to support the implementation of Universe in a Box. Calculated within the target was the amount it would cost to ship campaign rewards and the commission that Kickstarter takes from the total amount raised.

UNAWE has an extensive international network (The UNAWE Facebook page was liked by 2,343 people, and the Twitter page was followed by 4,627 people before the campaign launched), which gives a strong foundation from which to launch a crowdfunding campaign, but thorough preparation is also important for success. Almost one month full-time equivalent was spent before the launch date in preparing content for the Kickstarter page (words, photos, and video) and developing a plan of action for the campaign itself. We raised awareness about the campaign on the UNAWE web pages before launch to allow and encourage a "hype" to build.

5.2 Implementation

The campaign page can be viewed online at https://www.kickstarter.com/projects/unawe/universe-in-a-box.

The campaign was promoted through email and social media, contacted several journalists, and had phone calls or conversations with personal friends and contacts. The UNAWE team contributed to several blogs about the campaign, and other people also blogged about us.

Updates were posted on the UNAWE Twitter and Facebook accounts at least twice daily during the campaign. The website Peerreach was used to identify high-impact Twitter users, particularly within the relevant fields of Science and Education. These people were then sent personalised messages with a link to the campaign. Emails were sent out to various groups of potentially interested people throughout the campaign and to the UNAWE mailing lists at the beginning, middle, and end of the campaign. The UNAWE International mailing list has 1,749 subscribers, and the UNAWE NL mailing list has 844 subscribers. We prepared press releases and had media coverage through a variety of outlets. The results and lessons learned from this campaign were published in Ashton, Russo, and Heenatigala (2014).

5.3 Results

At the end of our 31-day campaign, €17,037 was pledged, exceeding our €15,000 goal. €15,463.56 was received from Kickstarter after its commission

had been deducted. Figure 1 shows how the number of pledges varied during the campaign.

The campaign resulted in 235 backers (average backing: €72.50), was shared 1,395 times on Facebook, and the video viewed 2,664 times (45.14% of plays were completed). The table below is a direct product from the Kickstarter page and shows where pledgers arrived at the Kickstarter page from. The largest amount was direct traffic, but a significant proportion of pledgers arrived at the site from the Twitter and Facebook links. Blog articles (University Today and astronomie.nl) and a widget embedded on the UNAWE website also contributed a reasonable amount to the campaign.

Figure 2. Global distribution of Universe in a Box. Interactive map available on: http://unawe.org/resources/universebox/

Table 2. Overview of the pledges' sources

Source	Number of backers	% Pledged	Amount Pledged (€)
Direct traffic (no referrer information)	97	42.46%	7,234
Facebook	26	8.74%	1,545
Twitter	24	9.07%	1,490
universetoday.com	14	5.52%	941
Other sources	14	15.0%	345
Embedded Kickstarter widget on www.unawe.org	9	5.05%	860
Advanced Discovery on Kickstarter	8	3.09%	526
Google searches	7	14.0%	695
unawe.org	5	3.44%	586

phys.org	4	1.12%	190
scienceblogs.de	4	0.82%	140
astronomie.nl	3	1.76%	300
Leiden University	3	0.56%	95
allesoversterrenkunde.nl	2	1.17%	200

Upon successful completion of the campaign, there were three main obligations: shipping of rewards to projects backers, fulfilling the targets set out by the campaign, and continuing to build and strengthen the community.

Evaluation & Discussion

At the time of writing, 700 international versions of Universe in a Box have been distributed to 40 countries (Figure 2). Teacher training sessions involving Universe in a Box have taken place in numerous countries. Feedback from these sessions after teachers have taken Universe in a Box activities back into the classroom has been resoundingly positive. Professional evaluation of all the boxes and the associated training sessions still have to be done, but preliminary anecdotal evidence shows that the children's understanding of concepts included in Universe in a Box increases after activities.

This chapter is a description of the processes and trade-offs that governed the development, production, and distribution of the flagship UNAWE educational resource, Universe in a Box. Many of the issues discussed are generic, but are relevant and should be taken account of when considering the development, production, and distribution of other educational resources, particularly those with an international focus.

Science and technology literacy is of crucial importance in education globally and has been recognised as essential by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) since 1984 in its series "Innovations in Science and Technology Education". The general view is that if we are to solve current and future social and environmental problems, then we need a generation of scientifically and politically literate people. Scientific literacy also has the potential to have huge impacts on underprivileged communities, either equipping people with practical solutions to everyday problems, by giving them passion and drive to pursue scientific careers, or by basically enabling people to think in different ways and make informed decisions.

Astronomy is a powerful tool for science education. Often communities in otherwise resource-poor countries have the clearest views of the night sky and, thus, an instant gateway into the study of astronomy and space sciences. These early exposures can inspire and engage people in studies of science and technology.

Bottom-up education resources in particular should be a major part of plans to develop or improve education in underprivileged communities. It is important that resources are locally relevant and sensitive and include cultural content where possible. Training is also an important part of resource development if these are to be employed effectively and not abandoned for

something that educators find easier or more relevant. Universe in a Box aims to take all of the above considerations into account.

An important result of UNAWE's work with Universe in a Box is a new framework for the development of future global educational resources (Ramchandani, 2013) based on the following principles:

- Co-development and collaboration (multiple partners) over single organization
- Co-production and distribution (with local partners) over top-down
- Co-ownership and branding (with smaller amounts) over licensing/franchising
- Co-funding (with smaller amounts) over large capital requirement
- Co-profiting (each partner benefits) while meeting a common goal

These principles form a new framework for the development of a "glocal" physical educational kit: one that could be globally standardised to an extent to gain economies of scale and scope, but localised to meet local requirements. This framework will be applied and exploited in future global educational projects, e.g. EU Space Awareness, a project funded by the European Commission between 2015 and 2017, that will use space to inspire children and teenagers and encourage them to embark on careers in the space industry.

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