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Open Standards in Science Education and Public Outreach: A Case for an Open Science Centre

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Open standards have revolutionised several fields of a knowledge-based economy. The most prominent case is in software development through open source. In this paper, we focus on open educational resources and their potential to facilitate access to education and learning resources. Following these standards, we propose the development of an open science centre (OSC). The OSC project aims to build a collaborative learning space based on open standards. The OSC will comprise creative learning spaces to inspire and engage local communities with science and technology and foster their sustainable development. These spaces will be low-cost, agile, participatory, based on open learning, and located in disadvantaged regions. The OSC is a collaborative project and open to every association, society, science club, school, individual, community, university and governmental organization that wishes to contribute to its development.

1. Open Standards in Science Education and Public Outreach

Open standards are processes, protocols, or resources made available to the general public and are developed (and/or approved) and maintained via a collaborative and consensus-driven process [1]. Open standards have some common characteristics: [2]

- Collaborative process – voluntary and market-driven development (and/or approval) following a transparent consensus driven process that is reasonably open to all interested parties.
- Reasonably balanced – ensures that the process is not dominated by any one interest group.
- Quality and level of detail – sufficient to permit the development of a variety of competing implementations of interoperable products or services.
- Publicly available – easily available for implementation and use, at a reasonable price.
- On-going support – maintained and supported over a long period of time.

There are several types of open standards (Fig. 1) that are relevant for Education and Public Outreach (EPO), like resources, software, data and licenses for education and public outreach (Fig. 2). In education, the most used standard is the open educational resources (OERs). OERs are teaching, learning and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing [3]. This concept has been further developed, making OERs cost free to the end-user and allowing the end-user freedom to Reuse, Revise/alter, Remix and Redistribute—the 4R framework [4].

The far-reaching impact of the OERs in society is not widely understood and is full of challenges on creation, use and evaluation [5]. Not all of these challenges

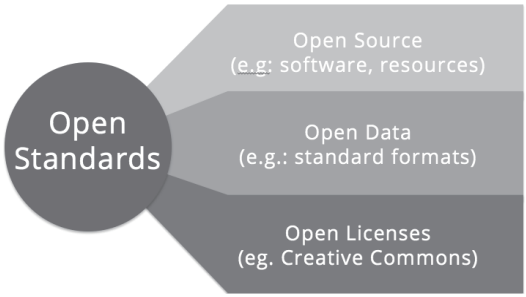

Fig. 1 Types of open standards relevant for education and public outreach. Credit: P. Russo & R. Monterde.

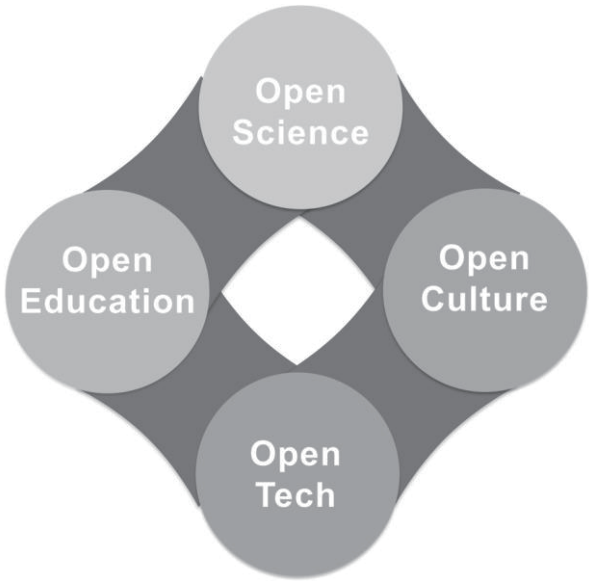

Fig. 2 Relevant open standards for education and public outreach. Credit: P. Russo & R. Monterde.

derive from the OER model, but from lateral reasons. For example the use of OERs is connected with the level of Internet access, knowing that two thirds of the world's population still doesn't have Internet access or the educational policies at different levels, within institutions and in government [6].

Moreover OERs are seen as a potential threat to educational content held by publishing houses. Although OERs offer a good solution for sharing knowledge, particularly when putting open educational resources on the Internet, ensuring these OERs are also of high quality remains a challenge. For example, to address this issue, IAU astroEDU (***www.iau.org/astroedu***) was developed. In this respect, astroEDU has enhanced the 4R model to a 5R model where Review, to ensure the resources are of the highest quality, becomes the fifth 'R' [7]. Open standards characteristics like a collaborative process, quality and on-going support

Fig. 3 Overview of the project: space, slogan and content. Credit: K. Romero.

make them an important approach to develop an ecosystem for science education, through the co-creation of a science learning space with science activities and resources. Those are the main characteristics of our proposed Open Science Centre (OSC).

2. What is the Open Science Centre?

The OSC fosters the sustainable development of local communities through science and technology (***www.opensciencecentre.org***). The OSC is an engaging learning space based on open standards: it features open architecture, open education, open technology and open science. The OSC's mission is to inspire, empower and engage citizens with science and technology (Fig. 3). Science and technology are engines for global sustainable development, however, they remain at times inaccessible for most of the citizens. The vision of OSC is to make science and technology accessible to all the communities, as a tool for their sustainable development. OSC mission is to inspire, empower and engage citizens with science and technology.

Table 1 Contribution of OSC to the UN Sustainable Development Goals.

UN Sustainable Development Goals [8]	Open Science Centre Contribution
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.	OSC will develop, produce, distribute and implement science and technology activities. These activities will be peer-reviewed and accessible to every type of learner (from school students to adults).
Achieve gender equality and empower all women and girls.	OSC will have specific programmes and activities to engage girls and women with science and technology topics.
Promote peaceful and inclusive societies, with access to justice for all, as well as facilitate means of implementation and revitalize the global partnership for sustainable development.	OSC is an inclusive learning space that will support peaceful and inclusive societies. OSC will establish a global network of science and technology educators.
Reduce inequality within and among countries.	As a low-cost science and technology infrastructure, OSC will contribute to reduce unequal access to science and technology to developing countries.
Take urgent action to combat climate change and its impacts. Protecting, and promoting sustainable use of energy and land, as well as the importance of biodiversity loss.	The relation between humans, our world and energy is a core theme of OSC. OSC will contribute to halt and reverse climate change also as an energy- efficient building.
Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.	OSC is a unique infrastructure that will foster innovation in economically and regional disadvantaged communities.
Build a new paradigm of responsible consumption, focus in the culture of sharing and creative production systems.	The open standards procedure aims to be a model and the core of new strategies for the sustainable development of settlements.

OSC will actively contribute to the following United Nations (UN) Sustainable Development Goals as described in table 1.

3. Open Science Centre Approach

OSC will follow an integrated approach to science and technology education. "*The amount of available information now doubles every five years*" [9]. That's why we must change our approach to education: teach "*people to be flexible and adaptable*" [10]. Thus, the OSC content will be also adaptable and flexible, focused on hands-on activities and guided with creativity. OSC Activities will engage communities with current and cutting-edge knowledge through the following five themes: our wonderful universe, our fragile planet, energy all around, mysteries of life and our exceptional body.

4. Open Science Centre Implementation

We are designing the OSC for low-income and/or remote communities, but the OSC will be open to everyone and can be established everywhere. As a proof of concept, we are developing an OSC in the northern part of the Netherlands to be opened in late 2016, but we are already discussing possibilities with partners

Fig. 4 Exterior of the Full-Fledged OSC proposal for the Netherlands. Credit: DE NAMEN.

in Brazil, Mozambique and other countries. The OSC will be available in the following modes:

- *Do-it-Yourself OSC*: Establish your own OSC. All the blueprints, plans, activities and ancillary resources will be freely available under a Creative Commons license. A network of scientists, teachers, students, artists and other professionals will be part of the online community to evaluate and improve all the content. Everyone will be able to interact with and download the information.
- *Out-of-Box OSC*: Educational activity kits will be available to transform any space (from a classroom to a garden) into an interactive and engaging science centre. These kits will be available at a target price of 50 EUR per theme.
- *Full-Fledged OSC*: A complete OSC will also available (Fig. 4), with all the necessary materials and equipment to open a science and technology centre in local communities. The OSC has a central versatile space that can be used for workshops during school and group visits or turned into a hands-on exhibition for walk-in public visits. OSC will have cutting-edge, open technology, including a small FabLab. The target price for the complete OSC will be under 100,000 EUR.

These are the main OSC milestones for the next year:

- November-December 2015: Project definition (including architecture, construction, educational content and evaluation strategy)
- Spring 2016: Do-it-yourself Guide BETA release
- September 2016: Full-fledged OSC Proof-of-concept Opening (The Netherlands)

5. Conclusion

The OSC will be "beautiful, accessible and meaningful spaces in which communities and individuals can meet, exchange ideas and solve problems" [11]. This contribution as a cultural and community shared space in rural areas is an attempt to establish the OSC as a new hub for activity and an attraction for the local young people to stay and thrive in their own communities.

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