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While the actions needed to restore the site to favourable status are largely a question of work on the building housing the specimens to control water ingress, it has emerged that, at present, neither Glasgow City Council, who own the site, nor the Trustees of the Fossil Grove are willing to commit any funds to the repair or upkeep of the building.

The most recent review of the overall status of Earth science SSSIs in Scotland, many in remote areas, reports that around 90% of the 500+ sites are in 'favourable' condition (Scottish Natural Heritage 2013 p. 134–137). Yet, this accessible site, which attracted a remarkable 17,000 visitors last year, is deteriorating for want of work on the building to protect the fossils and enable the Grove to serve as an amenity, educational resource, local geodiversity site (Whitbread and Arkley 2013) and data source for palaeobotany within the boundaries of the City of Glasgow.

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"Science without Barriers": towards the take-off of Social Palaeontology

Overview

The term "Social Palaeontology" (Torices *et al*. 2004) was coined to refer to experiences with people with both physical and intellectual functional diversity around a palaeontological site on the Campus de Somosaguas of the Complutense University of Madrid. Further from these pioneering practices, various experiences demonstrate the value of science popularization directed to people with disabilities (especially to people with intense learning difficulties and those who have undergone some sort of educational marginalization; see UNICEF 2010). These activities are not only a learning tool but a way of improving learners' self-image and, therefore, improve their quality of life (*e.g.* De la Ossa *et al*. 2012; Garcia-Frank *et al*. 2014b; Gomez-Heras *et al*. 2014).

Formal education *vs*. non formal education

Standard curriculum designs often lower learning outcome expectations for people with disabilities (Garcia-Frank *et al*. 2014a). This does not only include intellectual disabilities but

Figure 1. Enjoying palaeontological activities! A field-trip to Somosaguas palaeontological site (Madrid, Spain) for students with intellectual disability. Photos courtesy of members and collaborators of "Science without Barriers".

some sensory disabilities such as deafness or deaf-blindness, which is a particular case among sensory disabilities because of the combined difficulty of accessing educational contents and the learning difficulties associated with the complexity of acquiring language. Sensory disability becomes then a factor of deep, although often neglected, educational marginalization. This marginalization is even more noticeable in the Earth sciences, in which barriers to students with disabilities are given more importance than in other disciplines (Atchison and Martinez-Frias 2012). The case is even stronger in the context of non-formal education, although there is an increasing awareness of the importance of taking into account the needs of people with disabilities in designing Earth science curricula and teaching activities. These efforts are carried

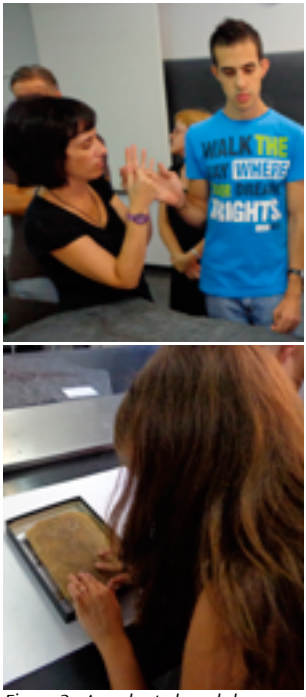

Figure 2. An adapted workshop for deaf-blindness students. Photos courtesy of members and collaborators of "Science without Barriers".

out by associations dealing specifically with these issues, like the International Association for Geoscience Diversity (IAGD) and the association "Ciencia sin Barreras" (Science without Barriers). In addition, long-standing professional organisations in Earth sciences like the Geological Society of London are also committing to diversity, equality and inclusion in geosciences.

"Ciencia sin Barreras" (Science without Barriers)

This association was founded in 2014 by a group of scientists and professionals related to disability seeking to promote inclusive learning and science literacy among people with disabilities, in line with the motto "Science for everybody". The activities organized so far have been done on a volunteer basis; the association's volunteers include, in addition to scientists, psychologists, social workers, university students and others who each bring their own expertise. The association follows mainly three lines of work: organization of activities (either specifically targeted to people with functional diversity or open to everybody); talks, lectures and educational research; and self-training and training of volunteers.

In 2016 the association was recognized as one of the 98 Innovative Practices and Policies with a focus on inclusive education and information and communication technologies (ICT) considered as worldwide role models in their field by the organization "Zero Project". The Project researches the status quo of the implementation of the UN Convention on the Rights of Persons with Disabilities (CRPD).

Palaeontological workshops and field-trips

Many of the activities organized so far deal directly with palaeontology and have been targeted towards people with deaf-blindness, short-sighted and blind people, and people with intellectual disabilities such as Down's syndrome. So far, successful lab-based activities adapted to people with both intellectual and sensory disabilities have been developed (Garcia-Frank *et al*. 2014a; 2014b; Gomez-Heras *et al*. 2014; Muñoz-García *et al*. in press). These demonstrate the great potential of geology to be successfully taught to people with disabilities via sensory activities that allow the acquisition of abstract concepts. They include field-trips to palaeontological sites and tactile workshops with fossils, rocks and minerals, revealing different aspects of geology. Also, a 'walking geological clock', coupled with relevant rock and fossil samples, was designed so that participants could gain a feel for the length of Earth history and its major milestones (Gomez-Heras *et al*. 2014).

One of our specific palaeontological workshops consists of three supplementary activities based on fossil tracks, the evolution of equids' limbs, and the main dentition types in vertebrates

(Iglesias *et al*. 2015). The principal goal of this activity is to teach, in a simple way, about past living beings, using replicas and actual vertebrate dentition and limb fossils, as well as images of animal tracks. In this way participants can reach their own reasoned conclusions regarding the organisms that generated them. It is important to remark that the subjective perception of this experience has been positive and the results of later surveys show the participants still recall most of the concepts learned in the session.

Other experiences are tailored for people with visual impairment and the goal is to share haptic experiences in order to perceive both shape and surface characteristics and internal structure under the 'learning-by-touching' principle (Chicote *et al*. 2015). The value of fossils in relation to this haptic experience lies not only in recognition of their forms, which would distinguish between different groups of organisms, but in the fact that these things are true witnesses of the fascinating history of our planet.

Final remarks

Every activity is prepared and designed with expert educators and other professionals related to disability who usually guide scientists with regard to the learning strategies and specific needs of the attendees. In addition to this, there is always a 'trial and error' component. We usually prepare a pilot activity in which we test the efficiency of the activities and materials proposed. After that, an evaluation is made (questionnaires, structured interview, *etc*.) to highlight the strengths and weaknesses of the activities, from both educational and social perspectives. These past two years have been a steep learning curve for us in which we have learnt from our mistakes and identified the best practices in the design of the activities. The most common errors are the same as those we find in any science dissemination activity: namely, trying to fit too much content in to one activity and failing to 'tune' the language to the public ear.

All of the scientists involved in the activities have experience teaching at university level and they use their expertise and experience of innovation to create materials that can bring scientific concepts within the reach of people regardless of their ability, thus eliminating barriers to learning.

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For further information please see our website: <**http://cienciasinbarreras.theiagd.org/**>

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Figure 3. Palaeontological workshop for adults with intellectual disabilities. Photos courtesy of members and collaborators of "Science without Barriers".

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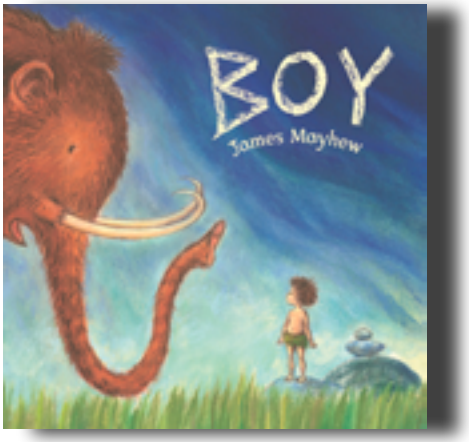
0–5 in 3 billion years

How do you engage a group of under-fives in a museum? Especially a museum whose objects are millions, if not billions of years old, and kept behind glass with a scattering of 'Don't touch' signs? Chesterton Children's Centre in Cambridge, UK, was up for the challenge, and last year a group of 12 families with children ranging from 5 months to 2 years visited the Sedgwick Museum of Earth Sciences, also in Cambridge. Just getting in to the Museum up the stone staircase looks daunting if you have a buggy, but we do have a (soon to be upgraded) lift. After this adventure into the Museum and meeting Iggy our 5m high *Iguanodon* skeleton we settled down to a story.

Stories are a brilliant way to introduce the themes of a museum and a way to introduce objects that are appropriate for handling. When I was planning the session I realized that most of my handling collection, although great for kids because it is fairly indestructible (being mostly made of rock), is not ideal for very small people, who might throw or drop things onto very small feet. However stories like "Boy" by James Mayhew have plenty of potential for introducing touchy feely objects and simple themes like hot and cold.



Courtesy of Hachette publishers.

Boy's cave is cold and he wants to warm up. His adventure takes him into a forest where he meets a sabre-toothed tiger and into the