Earthlearningidea: A Worldwide Web–Based Resource of Simple but Effective Teaching Activities

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ABSTRACT

Earthlearningidea was developed, without funding, to publish a new Web-based earth science teaching idea every week during the International Year of Planet Earth (2008); during 2009, publication continued, but at monthly intervals. The activities were mostly practically based and were aimed particularly at teachers and teacher educators in the developing world, who teach in classrooms with minimal resources, and they aimed to develop active and inquiry-based learning approaches. Earthlearningidea's success is indicated by the fact that, by December 2009, 69 activities had been published, activity pdf files had been downloaded more than 110,000 times, and the blog had been accessed in 152 countries, with positive feedback from many teaching situations. Many of the Earthlearningideas had also been translated into Spanish, Italian, Norwegian, and Chinese (Mandarin). Analysis of those who accessed the Earthlearningideas showed that the majority were from the more developed world. Thus, during 2010–2011, the activities, which were published each fortnight, were created to be slightly more sophisticated than previous activities, for example, in using equipment likely to be available in a school science laboratory, or more abstract ideas. The "stop press" update shows that the success of Earthlearningidea, measured by a range of indicators, is increasing. We ask all our readers to access the site, use the activities, give us blog feedback, and "tell their friends" across the globe. © *2013 National Association of Geoscience Teachers*. [DOI: 10.5408/10-159.1]

Key words: practical activities, inquiry-based learning, thinking skills, Web site, blog, translation

EARTHLEARNINGIDEA SYNOPSIS

Earthlearningideas can be accessed at the http://www.earthlearningidea.com Web site (Earthlearningidea, 2010), or through a search engine like Google by typing "Earth learning idea." Each Earthlearningidea is an earth science teaching activity, free to download and use, with the aim of teaching earth science knowledge and understanding through active and often inquiry-based teaching methods. The initiative was developed by volunteers because funding bids for other global earth science teaching initiatives had failed, showing how failure can be changed into success by voluntary effort and "thinking outside the box." The site was launched in 2007, activities have been added steadily since then, and the site contained 69 Earthlearningideas by December 2009; since then, a new activity has been added each fortnight. The activities are written for teacher educators and teachers to use, and so do not require printing, unless they are to be taken to a school that has no computer. Some of the "paper and pencil" activities do require single pages to be printed for use by pupils or groups of pupils; however, general classroom access to computers is not required.

The activities were designed for teaching situations in the developing world, where there are few or no resources. However, since Web site feedback showed that Earthlearningideas were being widely used in more developed countries too, the decision was made at the end of 2009 to include slightly more sophisticated activities, requiring normal school laboratory apparatus or more abstract ideas. Earthlearningideas are now being widely used across the world with great success (according to anecdotal feedback from the blog) and have been translated into several languages. Between November 2008 and November 2009, there had been 110,154 downloads of Earthlearningidea activities.

THE SPRINGBOARD FOR THE EARTHLEARNINGIDEA INITIATIVE

Earthlearningidea was born out of frustration!

At the International Geological Congress in Florence, Italy, in August 2004, the announcement was made that the International Union of Geological Sciences (IUGS) was bidding to the United Nations Educational, Scientific, and Cultural Organization (UNESCO) for 2008 to become the "International Year of Planet Earth" (IYPE) and that, if the bid was successful, 20 million US dollars would be raised to support the initiative. Uniquely for an "International Year," only half the funds would be designated for research, and the other half would be allocated to "outreach."

With the realization that, for the very first time, significant sums of money would become available globally to support geoscience outreach across the world, the Earth Science Education Unit (ESEU), based at Keele University in the UK, put together a bid for IYPE funding to run ESEU-style pilot workshop-based operations in the Philippines, Trinidad, and South Africa. This bid was supported by the International Geoscience Education Organisation (IGEO) and the IUGS Commission on Geoscience Education, Training, and Technology Transfer (IUGS-CoGE). Had the bid been successful, further funding would have been sought to roll the initiative out internationally. An ESEU-style operation involves developing geoscience educational material in collaboration with local country representatives, appointing and training local facilitators to deliver the

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materials to teachers through workshop sessions, and funding the workshops so that the facilitators can visit schools and deliver the workshops free of charge. This approach has been shown to be very effective in changing geoscience teaching in schools (Lydon and King, 2009).

Preparation of the bid involved a considerable amount of work:

- First, information was collected through the IGEO network, supported by the IUGS-CoGE committee, from as many countries as possible around the world to discover which of them would be most appropriate for a geoscience educational initiative.
- The data were evaluated, and the three countries noted above were chosen.
- Through many exchanges between the ESEU and country representatives, a costed bid was developed, requiring total funding of £285,338 (about US$ 570,000 at the time), asking for £142,669 (around US$ 285,000) and providing the remainder (another £142,699/US$ 285,000) through matched funding (largely to be donated "in kind").
- The bid was submitted, and received by the IYPE committee in April 2007 and …
- *nothing happened.*
- None of the sponsoring organizations, ESEU, IGEO, or IUGS CoGE, ever received a formal response to the bid.
- Much later, the information was received anecdotally that the US$ 20 million funding sought to support the IYPE had never been forthcoming, and, even if it had, the prospect of spending half of the "outreach" funding on one initiative would have been very unlikely.

Faced with the prospect of there being no ESEU-related geoscience educational initiative for the International Year of Planet Earth, three of the ESEU facilitators contemplated what could be done, and developed the idea of a Web-based resource that could be used by teacher educators and teachers across the developing (and developed world). This idea was put to the ESEU steering committee for ESEU funding, and it was again unsuccessful. The steering committee argued that ESEU funding had been provided by UKOOA (now "Oil and Gas UK"), the representative organization of the oil and gas industry in the UK, specifically for work in the United Kingdom, and not to support any international initiatives.

Thus, the three ESEU individuals involved decided to "go it alone" by developing the Web site and materials in a voluntary capacity, with no funding at all. So, on this basis, Earthlearningidea was born.

EARTHLEARNINGIDEA AIMS AND OBJECTIVES—EARTH SCIENCE EDUCATION FOR THE DEVELOPING WORLD

The Earthlearningidea project, as originally envisaged, is outlined by King et al. (2007), and the Earthlearningidea aims and objectives, as given on the Web site at the time (Earthlearningidea Web site), are shown in Box 1 and can be summarized in the Earthlearningidea refrain:

- an earth science teaching idea at regular intervals;
- at minimal cost, with minimal resources;
- for teacher educators and teachers of earth science through school-level science or geography;
- an online discussion around every idea;
- to develop a global network.

The ideas were therefore activity-based, but they used only apparatus and materials likely to be available in classrooms with few or no resources, like many of those in the developing world. They focused wherever possible on active learning and inquiry-based approaches. The objective was to reach teacher educators wherever possible, as they are likely to have internet access (even in the developing world). The teacher educators would then teach teachers who would be able to reach the greatest number of pupils.

Online discussion about the activities is based on a blog, which makes the Web site more interactive, offers support to those trying the ideas out for the first time, and provides feedback to the Earthlearningidea team on where and how Earthlearningideas are being used.

Earthlearningideas were brought to an international audience by the article published by Kennett (2008) in *Planet Earth*, the official publication of the International Year of Planet Earth.

EARTHLEARNINGIDEA OBJECTIVES IN ACTION

The objectives of Earthlearningidea can be exemplified through all the Earthlearningidea activities, categorized in Table I and detailed in Table II. The activity reprinted in Box 2, "High flow, low flow? Atmosphere and ocean in a tank: Hot, cold, and particle-filled density currents as they flow in the atmosphere and ocean," is used as an example. Table III shows how the different sections of an Earthlearningidea activity sheet, which normally occupies only two A4-sized pages, are applied in the context of the "High Flow, Low Flow" example.

THE DEVELOPMENT OF THINKING SKILLS THROUGH EARTHLEARNINGIDEAS

The majority of Earthlearningideas can develop the thinking skills of pupils, if used with this objective in mind. The ways in which thinking skills can be developed are based on the structure developed in the Cognitive Acceleration through Science Education (CASE) initiative (Adey et al., 2001). This has been a very successful initiative in UK schools for 11–12-y-old pupils, and has made sweeping, but research-based, claims of improvements in examination results in science of more than 20%, accompanied by similar increases in performance in math and English (the examinations being taken 1 y and 3 y after the implementation of the 30-lesson CASE intervention) (Shayer, 1999, 2000). The CASE initiative used a range of practical activities, primarily with groups of pupils, to develop:

- **construction** or pattern-seeking skills—pupils are asked to collect data and analyze it for patterns;
- **cognitive conflict**, cognitive dissonance or challenge—they encounter data which doesn't fit the previously identified pattern and are challenged to

BOX 1: Earthlearningidea Aims and Objectives, as Initially Published on the Web Site

Aim

To develop an internet-based support network for teacher trainers and teachers of earth science across the globe, by providing educational resources that will promote interactive teaching and the development of investigational and thinking skills, while provoking educational debate and minimizing costs by using voluntary effort and commitment wherever practicable.

Objectives

- To develop an internet-based support network and discussion forum capable of providing educational materials to educators across the globe, using modern internet tools.
- To promote the network/forum to teacher trainers and teachers of earth science, through science, geography, or related disciplines, focusing on pupils of ages 8–14 but suitable for younger and older pupils as well.
- To develop 57 earth science–based activities that will enhance knowledge and understanding of Earth, will promote interactive teaching skills in teachers, and will develop investigational and thinking skills in pupils in ways relevant to their everyday lives, while provoking educational debate around the activities. Each activity will be attractively presented, easily downloadable, and will have associated notes for teachers and teacher trainers.
- To publish five of these activities across the internet in September to December 2007 as a run up to the International Year of Planet Earth (IYPE), and one activity per week (52 activities) during the IYPE in 2008.
- To highlight the earth science principles, to tease out the underpinning scientific/ geographical principles, and to identify the underlying educational principles for each activity.
- To encourage positive global discussion around each activity to explore its educational potential and potential for developing knowledge and understanding of Earth and its processes.
- To encourage members of the global network to submit more activities that can be approved and edited for publishing in 2009 and beyond.
- To develop a support network of committed earth scientists, educators, and others around the project.

explain the meaning of the new data and its fit or lack of fit with the pattern identified;
- **metacognition**—pupils are asked to discuss how their thinking developed through the activity;
- **bridging**—they are asked to apply their new ideas in different contexts, thus clarifying understanding of the newly developed thinking skills and appreciating their relevance in new situations.

In the case of the "High flow, low flow? Atmosphere and ocean in a tank: Hot, cold, and particle-filled density currents as they flow in the atmosphere and ocean" activity, pupils should **construct** a "pattern" of water density and its effects being controlled by temperature. The introduction of milk (of unknown composition and so unknown density) causes **cognitive conflict**, with most pupils thinking it will flow along the middle or top of the tank; further cognitive conflict ensues when the milk flows very clearly along the base of the tank, requiring further explanation in terms of density. If the class is then involved in carefully controlled discussion about how their ideas developed, **metacognition** can take place. Finally, **bridging** takes ideas from the tank activity and develops them in the "real world" of the atmosphere and ocean.

THE POWER OF PREDICTION

This activity can be used to illustrate the "power of prediction" in science teaching by inviting pupils to predict the likely outcome before each run.

This works most effectively if the pupils are invited to discuss the likely outcomes with their neighbors before making their predictions, giving increased interaction and giving the pupils extra confidence in their predictions. In the ensuing discussion, as many different predictions as possible are collected by the teacher and voted upon, so that each pupil has a personal investment in the likely outcome. If a prediction discussion is run effectively, you can usually hear a pin drop during each run as pupils watch the outcome very carefully, to discover if their prediction was right.

"Prediction" used in this way has "power" in three different ways:

- the pupils watch the activity very much more closely than they otherwise might have done;

TABLE I: Earthlearningideas categorized (as of December 2009).

Earthlearningidea Category	No. of Activities
Earth as a system	6
Earth energy (including all natural Earth processes)	18
Earth in space	2
Earth materials	6
Evolution of life	10
Geological time	3
Investigating Earth	5
Natural hazards	9
Resources and environment	10

TABLE II: The Earthlearningidea activities list to December 2009.

No.	Week/Month	Category	Title
1	Sample	Natural hazards	Quake shake—Will my home collapse? When an earthquake strikes—Investigate why some buildings survive and others do not
2	September 2007	Investigating Earth	When will it blow?—Predicting eruptions: How a simple tiltmeter can demonstrate the bulging of a volcano before eruption
3	October 2007	Natural hazards	A tsunami through the window—What would you see, what would you feel? Asking pupils to picture for themselves what a tsunami through the window might look like
4	November 2007	Earth materials	Rock detective—Rocky clues to the past: Investigating your local rocks to find out how they formed
5	December 2007	Earth materials	Modeling for rocks: What's hidden inside—and why? Investigating the permeability of rocks and how they let water, oil, and gas flow through
6	7 January 2008	Evolution of life	Dig up the dinosaur—Become a fossil hunter and dig up a dinosaur
7	14 January	Earth materials	What was it like to be there—In the rocky world? Bringing the formation of solid rock to life by imagining yourself there when it formed
8	21 January	Resources and environment	Why does soil get washed away? Investigating why some farmers lose their soil through erosion whilst others do not
9	28 January	Earth energy	The Himalayas in 30 seconds! Making a miniature fold mountain range in an empty box
10	4 February	Earth as a system	The rock cycle in wax: Using a candle to demonstrate the rock cycle processes
11	11 February	Earth energy	Sand ripples in a washbowl: How asymmetrical ripple marks form in sand
12	18 February	Earth energy	Sand ripple marks in a tank: How symmetrical ripple marks form in sand
13	25 February	Earth energy	Mighty river in a small gutter: Sediments on the move
14	3 March	Evolution of life	The meeting of the dinosaurs—100 million years ago: The evidence given by dinosaur footprints
15	10 March	Natural hazards	A landslide through the window—What would you see, what would you feel? Asking pupils to picture for themselves what a landslide through the window might look like
16	17 March	Earth energy	A valley in 30 seconds—Pulling rocks apart: Investigating faulting in an empty box
17	24 March	Evolution of life	How to weigh a dinosaur: Using a dinosaur footprint impression to estimate how heavy the animal was
18	31 March	Natural hazards	Earthquake through the window—What would you see, what would you feel? Asking pupils to picture for themselves what an earthquake through the window might look like
19	7 April	Natural hazards	Surviving an earthquake—Learn the earthquake drill and increase your chances of survival
20	14 April	Geological time	Laying down the principles: Sequencing the events that form rocks through applying stratigraphic principles
21	21 April	Earth energy	Rock, rattle, and roll: Investigating the resistance of rocks to erosion by shaking in a plastic container
22	28 April	Resources and environment	Permeability of soils—The great soil race: Investigating the properties of different soils by pouring water on them
23	5 May	Evolution of life	A dinosaur in the yard: Was Iguanodon strolling in the sun, or fleeing in fear?
24	12 May	Resources and environment	Trapped! Why can't the oil and gas escape from their underground prison? Demonstrate how oil and gas can be trapped in reservoir rocks beneath the surface
25	19 May	Earth as a system	High flow, low flow? Atmosphere and ocean in a tank: Hot, cold, and particle-filled density currents as they flow in the atmosphere and ocean
26	26 May	Investigating Earth	Earth science out of doors—Preserving the evidence: What evidence of the present times might we find in a million years from now?

TABLE II: continued.

No.	Week/Month	Category	Title
27	2 June	Earth energy	Make your own rock: Investigating how loose sediment may be stuck together to form a "rock"
28	9 June	Evolution of life	Fossil or not? Discussion about what is a fossil and what is not
29	16 June	Earth energy	Salt of the Earth: Who can make the biggest salt crystal?
30	23 June	Earth materials	Eureka!—Detecting ore the Archimedes way: Measuring density using a stick, string, a ruler, a bucket, and a bottle of water
31	30 June	Earth materials	The space within—The porosity of rocks: Investigating the amount of pore space between the "grains" of a model "rock"
32	7 July	Evolution of life	A time line in your own backyard: Hang pictures of the important events in the history of life on a string time line
33	14 July	Earth energy	Blow up your own volcano! Demonstrate the importance of gases in volcanic eruptions
34	21 July	Natural hazards	Flood through the window—What would you see, how would you feel? Pupils picture for themselves what a major flood through the window might look like
35	28 July	Evolution of life	Dinosaur death—Did it die or was it killed? Was this a Cretaceous crime scene? Using rock and fossil forensic evidence to find out
36	4 August	Resources and environment	Quarry through the window—What would you see, what would you not see? Asking pupils to picture what a quarry through the window might look like
37	11 August	Evolution of life	What was it like to be there?—Bringing a fossil to life: A series of questions to bring fossils, and the environments in which they lived, to life
38	18 August	Earth energy	See how they run: Investigate why some lavas flow further and more quickly than others
39	25 August	Earth as a system	Carbon goes round and round and round: Make your own carbon cycle
40	1 September	Investigating Earth	What is the geological history? Sequencing events to reveal a history using simple stratigraphic principles
41	8 September	Geological time	Where shall we drill for oil? Sorting out the sequence—oil prospect
42	15 September	Natural hazards	An eruption through the window: How could an eruption transform your view? —Lava, ash, lahar, or something worse
43	22 September	Earth energy	Metamorphism—That's Greek for change of shape, isn't it? What changes can we expect when rocks are put under great pressure inside Earth?
44	29 September	Earth as a system	Space survival: How could we survive a year in a dome? Pupils plan to survive for a year in a sealed dome in a desert
45	6 October	Natural hazards	Tsunami: What controls the speed of a tsunami wave?
46	13 October	Earth energy	Weathering—Rocks breaking up and breaking down: Matching pictures and descriptions of weathered rocks with the processes of weathering that formed them
47	20 October	Earth energy	Cracking the clues: Making your own cracking clues to Earth's past
48	27 October	Resources and environment	Rocks to eat? How we get the elements we need to stay healthy?
49	3 November	Natural hazards	Earthquake prediction—When will the earthquake strike? Modeling the buildup of stress and sudden release in Earth that creates earthquakes
50	10 November	Evolution of life	How could I become fossilized? Thinking through fossilization in the context of me or you
51	17 November	Earth energy	Squeezed out of shape: Detecting the distortion after rocks have been affected by Earth movements
52	24 November	Earth as a system	Rock cycle through the window: The rock cycle processes you might be able to see, and those you can't
53	1 December	Geological time	Environmental detective: Imagining how the evidence of modern environments could become preserved
54	8 December	Resources and environment	Groundwater—From rain to spring: Water from the ground. Demonstrating how water flows through the ground, and how it can be used and polluted

TABLE II: continued.

No.	Week/Month	Category	Title
55	15 December	Earth as a system	The carbon cycle through the window: How much evidence of the carbon cycle can you see through the window?
56	22 December	Earth in space	Why does the Sun disappear? Demonstrate what happens when the Moon hides the Sun
57	29 December	Resources and environment	Power through the window: Which power source might be built in the view you can see from your window?
58	January 2009	Earth materials	Darwin's "big soil idea": Can you work out how Charles Darwin "discovered" how soil formed?
59	February 2009	Investigating Earth	From an orange to the whole Earth: Using an orange to model different densities of Earth's layers
60	March 2009	Earth energy	Grinding and gouging: How moving ice can grind away rocks
61	April 2009	Earth energy	Dust bowl: Investigating wind erosion
62	May 2009	Earth energy	Dam burst danger: Modeling the collapse of a natural dam in the mountains—and the disaster that might follow
63	June 2009	Investigating Earth	Darwin's "big coral atoll idea": Try thinking like Darwin did to solve the coral atoll mystery
64	July 2009	Resources and environment	Make your own oil and gas reservoir: Demonstrating how oil and water flow through permeable rocks
65	August 2009	Evolution of life	Trail-making: Making your own "fossil" animal trails
66	September 2009	Earth energy	Sandcastles and slopes: What makes sandcastles and slopes collapse?
67	October 2009	Resources and environment	"Water, water everywhere but not a drop to drink'": Investigating how to get clean water from dirty "pond" water
68	November 2009	Earth in space	Craters on the Moon: Why are the Moon's craters such different shapes and sizes?
69	December 2009	Resources and environment	Riches in the river: Investigating how valuable ores may become concentrated on river beds

- since prediction is an important component of "construction" as used in the CASE intervention, its use contributes to the development of thinking skills in pupils; and
- this is the way scientists often work, by making and testing predictions. Indeed carrying out scientific investigations, many of which involve predictions, is currently an essential part of the "how science works" component of the National Curriculum for Science in England (QCA National Curriculum Web site [QCA, 2010]).

EARTHLEARNINGIDEA: DEVELOPING NEW APPROACHES TO TEACHING, AND REVITALIZING OLDER ONES

Earthlearningidea has developed a range of different approaches to earth science teaching, encouraging active learning and inquiry-based approaches, as described next.

"Science through the Window"

Several of the Earthlearningidea activities develop a "science through the window" approach. This approach has been used as part of a series of activities by the Association for Science Education (ASE) Working Group in the UK in an attempt to encourage teachers to use the "outdoor classroom" more frequently and more effectively. The ASE approach begins with "science through the window" activities, which invite pupils to apply their science understanding to the view through the classroom window. It then develops to "science through the door,' where pupils use the school grounds for scientific investigation, before progressing to "science through the gate" involving fieldwork beyond the school. Earth science elements of this approach were described by King (2006).

The Earthlearningideas published by December 2009 that develop the "through the window" approach as thought experiments include: "Carbon cycle through the window"; "Rock cycle through the window"; "Earthquake through the window"; "Flood through the window"; "Landslide through the window"; "Tsunami through the window"; "Volcanic eruption through the window"; "Quarry through the window"; and "Power through the window."

What Was It Like To Be There?

Some Earthlearningideas also develop a novel "What was it like to be there?" approach, asking pupils to picture what an environment might have been like in the past through a thought experiment. These are based on geological evidence but ask pupils to use their imagination and all their senses to gain a real "feel" for past environments and the processes that might have been active at the time. The "What was it like to be there?" Earthlearningideas published include: "Rocky world—What was it like to be there?"; "Fossil world—What was it like to be there?" and "Trail-making: making your own 'fossil' animal trails."

Interactive Modeling

Numerous Earthlearningideas build a simple model of an earth science phenomenon and use it as a classroom demonstration of the process in action. As with all such simulations, some parts are accurate to real-world processes and others have scaling and other issues that cause them to differ from the real world. If discussion is managed carefully around the models and their similarities and differences with reality, they can be powerful learning tools that can be used to bring a dynamism to normal classroom teaching. The Earthlearningideas published that use a model-making approach include the "High flow, low flow? Atmosphere and ocean in a tank" activity shown in Box 2 together with: "Quake shake—Will my home collapse"; "When will it blow—Predicting eruptions"; "Dig up the dinosaur"; "The Himalayas in 30 seconds"; "The rock cycle in wax"; "Mighty river in a small gutter"; "A valley in 30 seconds"; "Laying down the principles"; "Trapped! Why can't the oil and gas escape from their underground prison?"; "The space within—The porosity of rocks"; "Blow up your own volcano"; "See how they run" (lava simulation); "Metamorphism—that's Greek for change of shape, isn't it?"; "Tsunami"; "Earthquake prediction—When will the earthquake strike?"; "Squeezed out of shape"; "Groundwater—From rain to spring"; "Why does the Sun disappear?"; "From an orange to the whole Earth"; "Dam burst danger"; "Make your own oil and gas reservoir"; "Sandcastles and slopes"; and "Craters on the Moon."

Investigating Real Phenomena

Some of the Earthlearningideas allow pupils to investigate real Earth phenomena in real time and real space. As well as modeling the oceans and atmosphere, the "High flow, low flow? Atmosphere and ocean in a tank" activity demonstrates how density currents actually flow in small basins, such as puddles and ponds. Similarly the "Mighty river in a small gutter" activity allows investigation at the sediment size scale of sediment movement, braiding, and microdelta formation, as well as the modeling of a "mighty river." Other Earthlearningideas that allow investigation of real Earth phenomena in action include: "Grinding and gouging"; "Dust bowl"; "Salt of the Earth"; "Sand ripple marks in a tank"; "Sand ripple marks in a washbowl"; "Darwin's 'big soil idea'"; "Permeability of soils—The great soil race"; "Why does soil get washed away"; "Riches in the river"; and "Water, water everywhere but not a drop to drink."

Using the Local Environment

A step towards using the local environment for geoscience education is made by the "Science through the window" activities described here. This is taken further, encouraging teachers and pupils to go outside by "Earth science out of doors—Preserving the evidence."

THE EARTHLEARNINGIDEA WEB SITE—A STEEP LEARNING CURVE ON DEVELOPING WEB-BASED PUBLICATIONS

Lack of funding led the team to use free internet software to launch Earthlearningidea to the world. A wiki was used as a repository for the activities, and a blog was set up to advertise the project and link to the wiki Web site. Since none of the Earthlearningidea team was familiar with any of this, there was a substantial element of trial and error. The main priority throughout was that the activities should be easy to download in pdf format, and, of course, they were to be free to everyone who had access to the internet.

The Earthlearningideas were categorized according to eight geoscience elements that are common to the earth science components of national curricula across the world (King, 2007), namely:

- Geological time
- Evolution of life
- Earth materials
- Earth energy
- Earth as a system
- Natural hazards
- Resources and environment
- Investigating the Earth

An additional category called "Earth in space," has since been added, to include activities beyond Earth. The number of Earthlearningideas in each of these categories (as of December 2009) is shown in Table I.

The first post was published on the blog on 6 May 2007, and the first activity launched on 2 June 2007. By 18 June, Earthlearningidea had reached Nepal, and from there, the spread across the world was rapid, thanks largely to all the international geological organizations who were promoting the project.

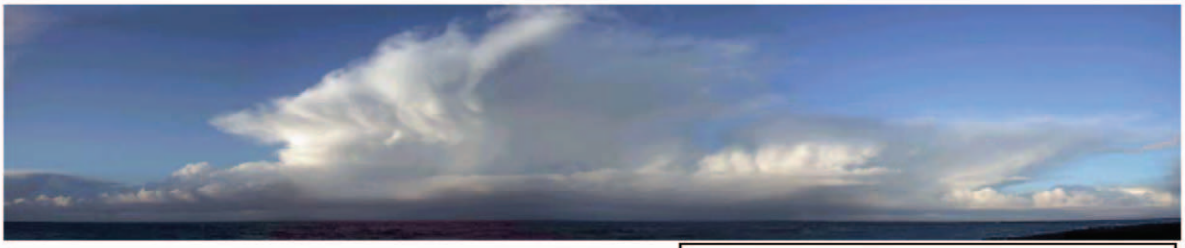
At first, the idea of producing video clips was not considered viable, but it soon became apparent that videos could indeed be used to good effect, and the first was published on 14 August 2007. By the end of August, there were sufficient useful comments from readers about the one published activity for "extension ideas" to be published. Comments were taken from the blog, collated, and published in pdf format on the Web site. Since then, blog feedback has usually been added as extension ideas, including the very limited negative feedback, usually couched as constructive criticism. By the end of August 2007, the activity had been translated into Spanish; both English and Spanish Earthlearningideas were incorporated into the Web site. By September, photos of the first activity being tried by pupils in India had been received.

The five activities published in 2007 were well received by a rapidly growing numbers of readers, but as soon as one activity per week was being published in 2008, it was clear that the layout of the Web site would have to be changed; the activities appeared on the Web site in a way that could be confusing to users, and it could be hard to find the one required. Eight new pages, corresponding to the eight categories, were created on the wiki Web site, and tables were used for clarity. In March 2008, Norwegian translations were offered, and a special Norwegian page was established on the Web site. In June 2008, Italian translations were added to the site.

A fundamental problem occurred in October 2008, when the international wiki system was updated, rendering the Earthlearningidea Web site unworkable in its then-current format. In view of the ever-increasing complexity and the decreasing ability of wiki-type software to meet the project's needs, it was decided to take matters wholly into the team's own control by constructing a new site in handwritten html. The Applied and Environmental Geophysics Research

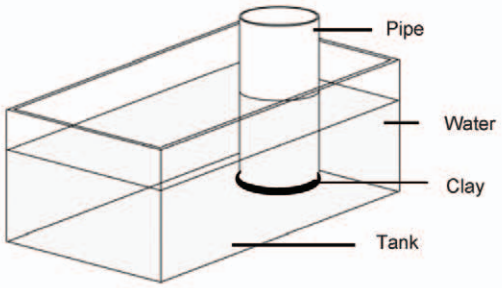
Box 2. Earthlearningidea Sample Activity. Used with permission.

High flow, low flow? atmosphere and ocean in a tank
Hot, cold and particle-filled density currents as they flow in the atmosphere and ocean



Cloud photograph copyright free. Found on:
http://yotophoto.com/search?page=10&kw=clouds

The set up
Half fill a transparent container with water (any size container will do – but the bigger the better – a plastic fish tank is ideal). Stand a piece of pipe, or something similar, at one end, as in the diagram.



The demonstration is more effective if a circular ribbon of clay is used as a seal between the pipe and the base of the tank – but this is not essential.

Hot current
Boil water and pour some (eg. about a quarter of a cupful) into a cup or similar container. Add some dye so that the water can be seen when it is added to the tank. Red-coloured dye is best (since the water is hot), but any dye will do, eg. food dye, ink, coffee, tea. Pour the dyed water into the pipe, stir the water in the pipe, then still it by stirring in the opposite direction. Then slowly and carefully remove the pipe and observe the effect.

The hot water will rise and then flow across the top, hitting the far side and 'bouncing back'. This hot layer can remain at the surface for some time – perhaps more than an hour.

Cold current
Leaving the hot layer as undisturbed as possible, repeat the demonstration with cold water. Pour cold water from a mixture of ice and water into a separate cup and add dye (eg. blue – cold).

When the pipe is removed, the cold water sinks and flows along the base of the tank, hitting the far side and bouncing back to form a stable layer at the base of the tank.

Milk current
Again, leaving the layers as undisturbed as possible, repeat the demonstration using milk.

The milk flows in a billowing cloud along the base of the tank, under the cold layer, bounces and forms another stable layer at the base of the tank.

To the real world
If the tank were representing the ocean:
- the hot water would be a warm current, flowing across the ocean surface like the North Atlantic Drift (or Gulf Stream) or like the warm surface waters in the Pacific Ocean during the El Niño effect;
- the cold water would be a cold current, as generated near the poles, that flows down and across the deep ocean floors;
- the milk would be a turbidity current, like the currents of water with sand and mud triggered by earthquakes, that flow down continental slopes and across thousands of km^2 of ocean floors.

If the tank were representing the atmosphere:
- the rising hot 'air' would be a low pressure area, with the hot 'air' flowing across the upper atmosphere;
- the sinking cold 'air' would be a low pressure area, with the cold 'air' flowing across the 'land surface' (base of tank) as 'wind'. As the cold 'air' flows across the foot of the tank, it displaces the warm 'air', like a cold front.
- the milk is like the density currents of solid particles in air produced by avalanches (ice crystals in air), volcanic nuées ardentes (white hot ash in air) or collapsing buildings, such as the Twin Towers of the World Trade Centre (dust in air).

An interactive approach
Pupils become much more involved and watch much more closely if they are asked to predict what will happen before each demonstration. They also learn more effectively that the results are controlled by density, and that the density 'ladder' eventually produced is: milk, most dense; cold dyed water, less dense; clear room-temperature water, even less dense; hot dyed water, least dense.

Box 2: continued.

The back up

Title: High flow, low flow?: atmosphere and ocean in a tank

Subtitle: Hot, cold and particle-filled density currents as they flow in the atmosphere and ocean

Topic: A demonstration of how density currents flow in a tank of water, used as an analogy to the oceans and atmosphere.

The tank in action. Photo: Peter Kennett

Time needed to complete activity: 20 mins

Pupil learning outcomes: Pupils can:

- describe and explain what will happen to: a hot body of fluid within cooler fluid; a cold body of water within a warmer fluid; a denser particle-rich fluid within a less dense fluid;
- describe how fluids of different densities can form discrete and separate bodies;
- use the demonstration to explain ocean processes: warm currents; cold currents; turbidity currents;
- use the demonstration to explain atmospheric processes: rising warm air low pressure areas, sinking cold air high pressure areas; wind; cold fronts; avalanches, nuées ardentes and dust density currents.

Context:

This activity can be used to introduce or reinforce understanding of atmospheric and/or ocean processes or, if used interactively, as an effective way of developing thinking skills, as outlined below.

Following up the activity:

Ask what will happen to dyed salty water if added to the apparatus. The salt water may be even denser than the milk, and flow along the bottom. This is why, in estuaries, a layer of fresh water is often found above a wedge of salt water beneath.

Ask what might happen in a pond to hot and cold water at different times of the year, and to muddy water introduced by a stream during a storm.

Ask why 'heat rises'. What phrase would describe what happens to 'cold'?

Underlying principles:

- Less dense fluids rise above and 'float on' less dense fluids.
- Bodies of fluid retain their integrity for long times, days and weeks in the context of the atmosphere and oceans.
- Much of vertical atmospheric and oceanic circulation is controlled by the different densities of the fluids involved, and much of this is controlled by their relative temperatures.

Thinking skill development:

A 'pattern' is constructed of water density and its effects being controlled by temperature; when milk is introduced (of unknown composition and so unknown effect), this causes cognitive conflict, and most think it will flow along the middle or top of the tank. Carefully controlled discussion involves 'metacognition' and then 'bridging' takes place from the tank to the real world of atmosphere and ocean.

Resource list:

- a transparent container – a plastic or glass fish or reptile tank is ideal, but any container, such as used in food packaging or food storage can be used; rectangular containers are best
- a piece of pipe or plastic tubing or a plastic cup with the base removed
- clay or modelling clay as a seal (optional)
- three containers (eg. cups, beakers)
- dye (eg. food dye, ink, coffee or tea)
- boiling water
- ice
- water
- stirring rod

Useful links:

See, for the atmosphere:
http://www.ucar.edu/learn/1_1_1.htm
and for the oceans:
http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/oceanography_currents_1.html

Source:

King, C. & York P. (1995) *'Atmosphere and ocean in motion'* in *Investigating the Science of the Earth, SoE1: Changes to the atmosphere*. Sheffield: Earth Science Teachers' Association, GeoSupplies.

Box 2: continued.

Group at Keele University came to the rescue and agreed to host the new site. Weeks of html writing, frustration, sleepless nights, and a steep learning curve followed, but by November 2008, the new, dedicated Web site was launched. Although this had taken a considerable amount of time, the logic and simplicity of the code now made it easy to make additions and alterations.

Being in total control of the Web site was liberating, and during the end of 2008 and into 2009, new links and additions were added. In March 2009, a link was made to translations in Mandarin Chinese, and it was possible to add the Chinese flag to the home page to join the English, Spanish, Norwegian, and Italian flags. Around this time, further links were added, for example, "Earthlearningidea

TABLE III: The different sections of an Earthlearningidea, exemplified by reference to the "High flow, low flow" activity.

ELI Section	"High Flow, Low Flow" Activity Example
Title	"High flow, low flow," with the reference to a tank, is used to capture the imagination of teachers/pupils.
Subtitle	The density current subtitle and reference to the atmosphere and oceans explains to teachers what the activity addresses.
The activity	This is described for the teacher in detail, so that the way the activity can be used is clear. In this case the "An interactive approach" heading explains how the activity can be used most effectively.
The backup	The teacher notes below the activity include the following.
Topic	A brief description of the activity, expanding a little on the title.
Age range of pupils and time needed to complete activity	This lists the most appropriate age range and timing for the activity.
Pupil learning outcomes	This lists what pupils should be able to do as a result of the activity; in this case, they should be able to describe what happens during the different runs of the activity and then apply this information to explaining oceanic and atmospheric processes.
Context	The way in which the activity could link to teaching schemes is covered here, while in many activities, answers to the questions set in the activity description are given.
Following up the activity	Different ways of extending and consolidating learning are provided here.
Underlying principles	This is where the scientific and geographical principles that underpin the activity are teased out and clarified, in this case the importance of fluid density and the integrity of bodies of fluid in ocean/atmosphere processes.
Thinking skill development	This lists how the activity could develop thinking skills described in more detail below.
Resource list, useful links, and source	These sections list the resources needed, links to useful Web sites, and the original source of the practical activity, with suitable acknowledgment.
Copyright box	All Earthlearningidea activities carry a copyright box explaining that copyright is waived for normal classroom usage, but that permissions should be sought for further use of the activities, particularly for any commercial use.

around the world." In October 2009, the first Tamil translation was added too.

The most recent major innovation to the Web site has been to introduce keywords, so making it easy for teachers to search for a particular topic. This list is being extended to make it more comprehensive for teachers of both science and geography. In the future, it is hoped that Earthlearningidea will provide a comprehensive list of Earth-related topics in science and geography and that children will benefit all over the world, no matter what their circumstances.

THE POWER OF THE "FREE"

Little did the Earthlearningidea team think, when the Web site was first set up on a voluntary basis, that "working for free" would turn out to be a really positive move—in that others could be asked to do the same. This has now paid handsome dividends in that a wide range of people across the world have been willing to help, by contributing freely to earth science education through Earthlearningidea.

Also, the team never imagined when Earthlearningidea was launched that people across the world would be so keen on the approach that they would be willing to translate it into their own languages—but that turned out to be the case. Now Earthlearningideas can be read in Chinese (Mandarin) (13 activities by December 2009), Italian (33 activities), Norwegian (32 activities), Spanish (34 activities), and Tamil (1 activity). We are very happy to acknowledge the enormous contributions our colleagues in these different languages have made to the spread of the Earthlearningidea approach. See the Acknowledgments section of the Earthlearningidea Web site, and the Acknowledgments section at the end of this article.

As volunteers, the team also felt able to approach colleagues at Keele University to host the Web site free of charge, and this they kindly agreed to do. So we would also like to greatly thank the Applied and Environmental Geophysics Research Group at Keele University for their help.

Meanwhile colleagues across the world, particularly members of the IGEO, have committed time and effort to publicizing Earthlearningidea in their own countries and regions, and we greatly value their contributions as well. We wonder if all this time and effort would have been so freely given if Earthlearningidea had not been developed on a voluntary basis in the first place.

IS EARTHLEARNINGIDEA A SUCCESS?—WHAT OUR AUDIENCE SAYS

It is very difficult to evaluate the success of an educational project of this type, since it is difficult enough to evaluate the impact of a project on teachers and learners in a single country. Carrying out a proper global evaluation worldwide is probably impossible and certainly expensive—and therefore beyond the capacity of the Earthlearningidea team.

So, we have sought other measures of success. The first of these is the number downloads of Earthlearningidea activities as pdf files. Each Earthlearningidea activity is presented as a separate pdf file, so the number of downloads is an indication of how frequently the activities are being accessed by Earthlearningidea users. Figure 1 shows the general increase of pdf downloads since the Web site was moved to Keele University in November 2008, a total of 110,154 downloads.

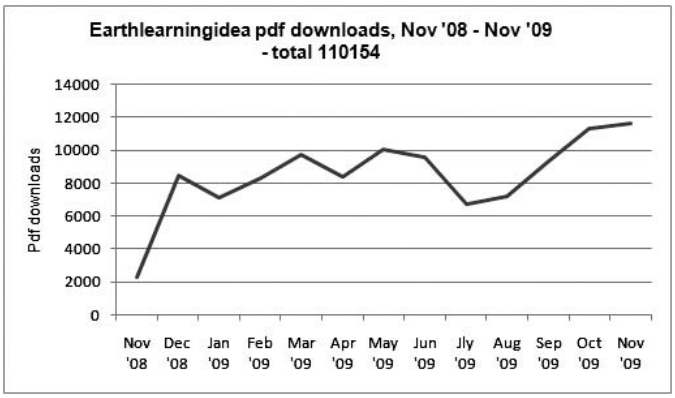


FIGURE 1: Numbers of Earthlearningidea activities downloaded as pdf files, November 2008–November 2009.

It is difficult to ascribe meaning to a figure of 110,154, but if a quarter of the downloads were actually used by teachers, and each teacher taught 20 pupils, the number of pupils reached would be more than half a million, worldwide. If some of the downloads were used by teacher trainers to train teachers, the number of pupils reached would be far higher.

A second measure of success is the number countries reached by Earthlearningidea, as recorded by the *Google Analytics* tool for the Earthlearningidea blog. This showed that to 31 December 2009, Earthlearningidea had reached 152 countries. A perspective of the number of hits per country is given in Fig. 2. The map shows that the top 10 Earthlearningidea countries in December 2009 were, in order:

1. USA
2. UK
3. Canada
4. Spain
5. India
6. Australia
7. Italy
8. Taiwan
9. Norway
10. Germany

A third measure of success is the anecdotal feedback received through the blog and by electronic mail, of the ways in which our activities have been used across the globe. Table IV gives a snapshot of some of this feedback, and you can see teachers being taught through Earthlearningidea in Figs. 3, 4, and 5. In addition to very positive comments like these, we have generated some constructive criticism of the activities (e.g., from an unknown country on 1 July 2008 in response to "A timeline in your own backyard" activity, "I prefer using a toilet roll as it gives a better sense of the large expanse of geological time"). Meanwhile a number of our bloggers have suggested "extension ideas" to some of the activities, which we have published on the Web site (e.g., from Canada, 8 January 2008: "This sounds like an easy and fun exercise ['Dig up the dinosaur']. If you wanted to add the concepts of stratigraphy, correlation, and that only certain layers are fossiliferous you could divide the sand into 3 buckets; mix cornmeal . . .").

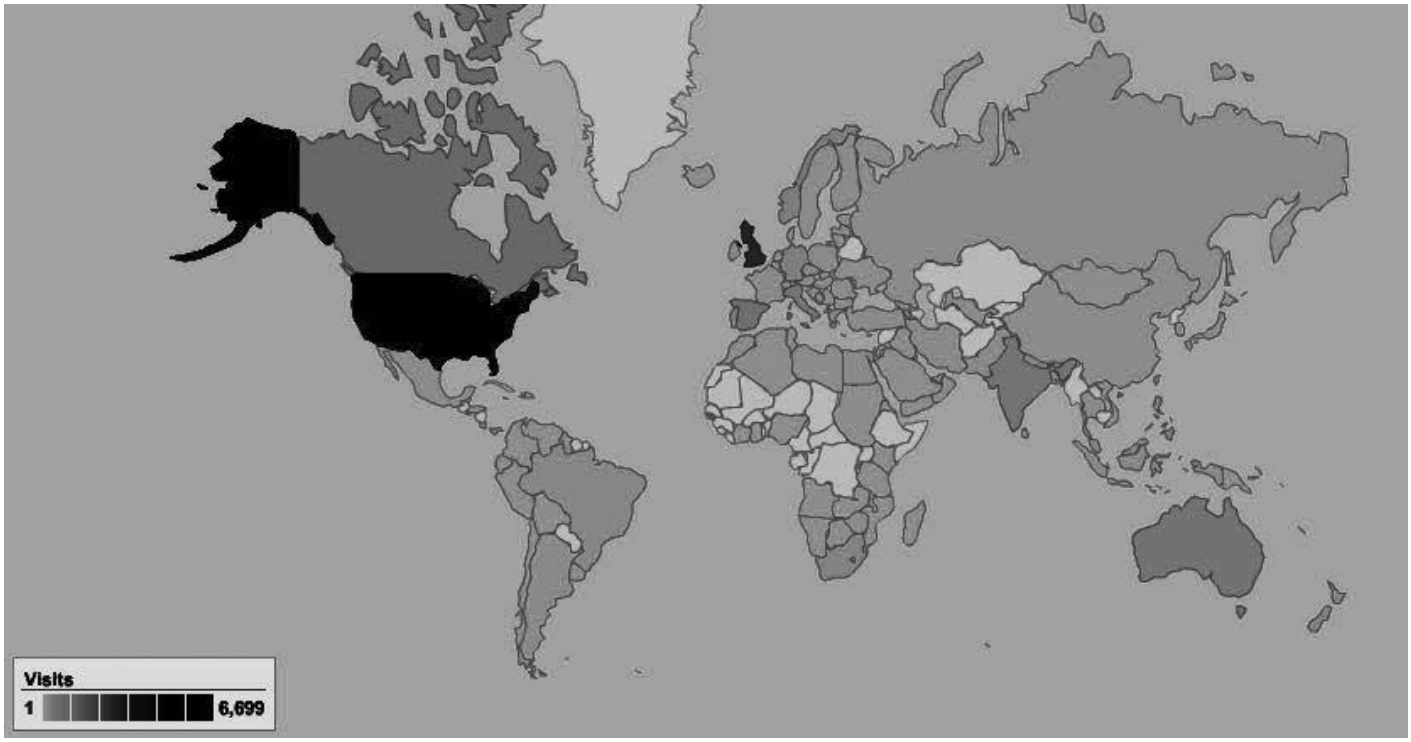


FIGURE 2: A chloropleth map of the number of Earthlearningidea blog hits per country, by 31 July 2009 between 0 (shown in pale gray) to 6,699 (shown in black) of the 15,996 hits recorded; information provided by *Google Analytics*.

A fourth measure of success is that our colleagues in different countries have felt that the ideas would be so valuable to the development of the earth science curriculum in their own countries that they have been willing to translate so many of the ideas into their own languages.

Finally, it is most encouraging that Earthlearningideas have been used as the basis of teacher training workshops in India, Italy, and South Africa. This is particularly so, as the original plan for contributing to the outreach aspect of the International Year of Planet Earth was to run teacher education workshops in countries around the world, and now this is happening, albeit not in the way originally envisaged. Recently, Roberto Greco published an article on the success of the activities in Italy (Greco, 2009). Articles have since been published in Spain (Greco, 2010; King et al., 2010).

It was surprising that the Earthlearningideas, which were originally developed for wide usage, but with the minimal resources available in classrooms in developing countries in mind, have been accessed more extensively in more developed countries. This is probably due to a wide range of factors that are likely to reduce usage in the developing world, including (anecdotally):

- little access to computers in teacher training institutions and classrooms;
- widespread didactic teaching styles that are not easily adapted to the use of practical activities;
- lack of training of teachers in activity-based learning;
- lack of equipment and materials;
- many curricula containing little or no earth science;
- lack of training of teachers in earth science teaching;
- language issues.

However, recent Web data (though 2010) suggest increased usage by developing countries (e.g., India and the Philippines), showing that it is worth persevering with the objective of bringing practical earth science activities to teaching situations across the globe.

FACTORS CONTRIBUTING TO THE SUCCESS OF EARTHLEARNINGIDEA

The factors that may have contributed to the continuing success of Earthlearningidea, as shown by the increasing access statistics around the world, may include:

- the development of innovative ways of teaching earth science, often involving practically based activities, active learning, and inquiry-based approaches;
- the presentation of each idea in accessible and interesting ways;
- the publication of a new idea regularly, giving the opportunity of reminding users of the Earthlearningidea resource;
- an attractive, easy to use Web site;
- each idea being quick to download and read (being confined to two A4 pages);
- the work being done by volunteers, encouraging others to become involved on a voluntary basis; and
- the support of members of the international network of the IGEO, further supported by the IUGS-CoGE committee.

EARTHLEARNINGIDEA FUTURE DEVELOPMENTS—EARTH SCIENCE EDUCATION FOR EVERYONE

At one stage, this article might have been a final report. However, the team decided towards the end of 2009 to

TABLE IV: Anecdotal feedback to Earthlearningidea activities provided through the blog and by electronic mail.

Date	Country	Feedback Received
18 June 2007	Nepal	"Many thanks; Earth Learning Idea seems very exciting especially as you will be using the International Year of Planet Earth and publishing 1 activity per week. The sample activity, "Quake Shake" was spot on for here, where we have an earthquake drill every term. Keep up the good work; it is imaginative and I think will meet a need in many poor countries like ours. Poverty doesn't only mean money, it means poverty of experience, learning, thinking ability - - - even books."
6 September 2007	India	I am attaching two photographs in connection with the demonstration that I gave of the "Quake Shake" experiment at Vishwa Mangala School, Mangalore University campus, yesterday, which happens to be teachers day. There was large group of students aged about 14 y. Some of them could easily explain the situation invoking the foundation factor. But they all indeed appreciated the demonstration and found it useful.
4 October 2007	The Philippines	An excellent activity that highlights the affective dimension of learning about tsunamis. Asking the students to "feel" the tsunami would galvanize them of the reality of the threat.
26 November 2007	Spain	Translation of a blog comment from Victoria Burjassot: "I am working on this activity ['Rock detective—about rock identification'] with my students of 1st ESO (12–13 y old) in the practical tasks (laboratory) of biology and geology. My students apply the scientific method (they make observations, ask questions, answer them and experimentally verify their answers) but in an almost intuitive way. It is becoming much more interesting for them and I prefer this way of teaching–learning about rocks from questions and observations than from the simple descriptive way we were using before. Congratulations for the idea."
16 March 2008	New Zealand	This ['Landslide through the window'] is a very good resource. It created interest, and the questions were well constructed. I was very impressed with the answers my pupils gave.
29 April 2008	China	This ['The meeting of the dinosaurs—100 million years ago'] is an excellent curriculum for students to learn how to use evidence to reconstruct an ancient environment and the activities of some of the animals.
1 June 2008	Sri Lanka	I am highly appreciative of these valuable teaching aids related to geoscience education.
12 October 2008	Italy	Hi, I am one of those 29 teachers who enjoyed the workshop and I'd like to thank Dr. Greco and ELI: The interactive methodology is very interesting and easy to learn. I like it. I'm sure my students will enjoy the activities very much too :)
10 August 2008	Not given	Monday night is ELI night! I am fascinated with the idea of becoming fossilised but 10,000 years is a long time to wait! This activity is going to grip the imagination of thousands. [Responding to: 'How could I become fossilized?']
2 October 2008	Russia	I am grateful for this project and that you send news regularly. I teach environmental geochemistry and biogeochemistry in the Department of Geography in Perm State University and I have used some Earthlearningideas as examples of geological and biological processes. I also recommend your site to my students.
3 February 2009	Not given	I just want to say how wonderful your activities are for pupils. I have been trying as many as I can. The best way to learn about earth science.
13April 2009	Taiwan	In my opinion this activity ['Imagine yourself in the rocky world'] is really suitable for the students who think rocks and minerals are boring. In this process, students can use their imaginations, creativity, the experiences of the world today, and the evidence preserved in the rocks to travel themselves to the past when the rock formed. This activity not only increases students' motivation to learn but also helps teachers design the traditional 'boring rock' curriculum more easily and with interest.
31 July 2009	South Africa	I am happy to inform you that we are having our first workshop this afternoon and tomorrow where we will be using your Earth Learning Ideas.

develop the Earthlearningidea concept to include activities that might previously have been excluded.

Since Earthlearningideas are being used in more developed countries, as well as in developing countries, across the world, the decision was made to publish a new range of activities that either used normal school laboratory equipment and materials (such as Bunsen burners and pH indicators) or more abstract ideas than were covered previously, such as those relating to plate tectonics and three-dimensional thinking. In pursuit of this goal, 26 new Earthlearningideas (ELI) were published as ELI Plus (ELI+) ideas during 2010 at a rate of one per fortnight, and a further 26 ideas were

FIGURE 3: **Teachers trying out Earthlearningideas in India in late 2008.**

identified for publication in 2011. This means that the balance of activities is moving towards an increased number of ELI+ activities, so that by the end of 2011, there will be around 50 ELI+ activities added to the original 69 ELI activities.

Meanwhile, any organizations that wish to use our Earthlearningideas around the world are welcome to do so, providing they seek permission, acknowledge the Earthlearningideas appropriately, and, where possible, give feedback on the activities. Others who are keen to translate Earthlearningideas into other languages are also welcome to do so, subject to the strictures above, but, if they do, we would ask them to set up their own Web sites that we would then link to, rather than offering to put the translated activities up on our own Web site (as this has sometimes caused us translation difficulties). Publishers around the world are also welcome to use the ideas, again, subject to suitable acknowledgment. We would welcome this as a way of improving the earth science content of textbooks around

FIGURE 4: **Teachers learning about Earthlearningideas in Italy in early 2009.**

FIGURE 5: **Teachers using Earthlearningideas in South Africa in late 2009.**

the world, which research has shown can often be factually incorrect (American Association for the Advancement of Science Project 2061 Web site [AAAS, 2010]; King, 2008) and may be presented in less than interesting ways.

Finally, we would ask readers of this article to support our activities by accessing the Web site, using the materials, and providing feedback to us via the blog or by electronic mail. If you like what you see, we would also ask you to tell your friends in regions across the world, as a means of developing and improving earth science education in schools across the planet. The more that Earthlearningideas are used, the more successful we will have been.

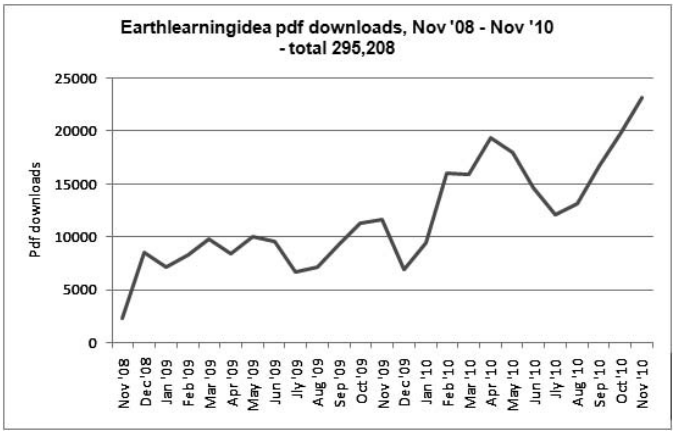


FIGURE 6: **Numbers of Earthlearningidea activities downloaded as pdf files, November 2008–October 2010.**

STOP PRESS

By October 2010:

- 91 Earthlearningideas had been published;
- Earthlearningidea pdf files had been downloaded 265,103 times since November 2008, with the pattern shown in Fig. 6.
- the Earthlearningidea blog had been accessed in 162 countries and 6,927 cities worldwide;
- the top 10 countries were in order: USA, UK, Canada, India, Spain, Italy, Australia, Germany, Philippines, and Taiwan—showing an increase in use by developing countries (India and the Philippines);
- Earthlearningideas are currently being translated into Portuguese and German; and
- an online free-to-download introductory geoscience textbook had been published, closely linked to Earthlearningideas (King, 2010b).

Acknowledgments

We are hugely grateful to all those who have supported us in the development of Earthlearningidea. In particular, we thank those who have translated for us, José Sellés Martínez (Pepe) from Argentina, Merethe Fryland from Norway, Roberto Greco from Italy, and Shao Yanxiu from China, and their teams, described on the Web site as follows:

- José Sellés Martínez—Spanish translation by Aula-GEA, a service for teachers and learners of the Department of Geology of the University of Buenos Aires. La traducción al español ha sido realizada por Aulagea, el programa de extensión del Departamento de Geología de la Facultad de Ciencias Exactas y Naturales de la Universidad de Buenos Aires.
- Merethe Fryland—Norwegian translations by Kari Beate Remmen and Anne Kristine Byhring, sponsored by the Norwegian Committee of the Year of Planet Earth.
- Roberto Greco—Italian translations by Barbara Scapellato, Claudio Casali, Bovino Miria, Sonia Manaresi, Giulia Realdon, Laura Agostini of ANISN (Associazione Nazionale degli Insegnanti di Scienze Naturali). Edited by Paola Fregni, Chiara Fioroni, Mauro Marchetti, Dipartimento di Scienze della Terra dell'Universitá degli Studi di Modena e Reggio Emilia e Corrado Venturini del Dipartimento di Scienze della Terra e Geologico-Ambientali dell'Universitá degli Studi di Bologna.
- Yanxiu and Zhang Lianhai of the Geoidea team. Geoidea is a network platform for teachers and students interested in geoscience.
- Michael Anjello Jothi Rajan—Tamil translations. Jothi is S. G. Lecturer, Department of Physics Head, Department of Religion and Value Education, Arul Anandar College, Karumathur in Tamil Nadu, India.

We are also grateful to the International Union of Geological Sciences Commission on Geoscience Education, for an unsolicited donation of $US 1,000 for the development of this project and to the Applied and Environmental Geophysics Research Group at Keele University for hosting the Web site free of charge.

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