digital-earth.eu – a European network for Digital Earth education

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ABSTRACT

European school education has so far, by and large, ignored geospatial developments like remote sensing, despite the fact that geo-technology has already become a significant employer. There are small pockets of intense activity, the challenge is to scale these developments up. This article reports on networking initiatives developed by the digital-earth.eu project to connect organisations involved in geospatial education like remote sensing, to share practice, provide advice and guidance on the use of geographic information to others and be a place for new initiatives.

The digital-earth.eu network project raises awareness of the role of digital earth education, informing politicians of the significance of digital earth tools and technologies. digital-earth.eu also establishes a teacher support network infrastructure which incorporates geo-services for teachers such as the use of ArcGIS Online for Organisations and the European Environment Agency EyeonEarth platform.

The project has made recommendation concerning the growing shortage of a geospatial workforce in Europe, the significance of open data and the usability of EU INSPIRE Directive. It suggests that Digital Earth education and training developments are urgently needed as part of the European Qualifications Framework. European policy makers have to be made much more aware of geospatial concepts and then actively encouraged by stakeholders to respond to them in policy terms through developing a “Digital Earth education for all”.

Keywords: ArcGIS Online, Centre of Excellence, Comenius programme, digital-earth.eu, Digital Earth, geoinformation tools, geo-ICT, lobbying, geospatial, geospatial workforce, network, networking, school education

1. INTRODUCTION

1.1 Context

In 1992, former US VP Al Gore presented a farsighted Digital Earth concept, whereby detailed geospatial information could be accessed from any place, at anytime, by anyone. The subsequent scientific and technological movement has made this vision a reality today. Based on a US Dept of Labor study, Gewin, writing in the scientific publication Nature, proposed that geo-technology (with related spatial thinking skills) would become one of three most significant technological advances for economic development in the next decade. Since then, in the United States there has been a strong lobby for geospatial education, resulting in Congress acknowledging the significance of the National Academies Press publication "Learning to Think Spatially". This has transformed the US research and education technology agenda and as a result the National Science Foundation recently awarded significant grants to geospatial education research. The same has not been the case in Europe.

1.2 Digital Earth and European school education

The Digital Earth vision connected groups of scientists interested in cooperative studies of the planet and its resources, and directed actions for solutions towards sustainable development. Since then Digital Earth technologies created a profound revolution in science and technology, information access and spatial planning. The acquisition and use of geospatial information, combined with developments in computing and communications has made information about the earth available to billions of people. The Digital Earth concept has become a reality and the results should play an increasingly important role in addressing the social, economic, cultural, scientific, and technological challenges affecting the way we understand the earth. Global agencies like the United Nations have established expert groups to coordinate dialogue, advise and inform on geospatial matters. Specifically, Digital Earth allows us to focus the attention on many
of the important challenges faced by Europe today, such as economic efficiency, resource depletion, sustainable energy, natural hazards, food and water supplies, environmental degradation, population migration and smart cities.

The recent developments of geographic (geo-)media can be used to bridge the gap between citizens, Digital Earth technologies and real-world problems by socially connecting them through geographic location services. Geo-media therefore has the capacity to create powerful learning opportunities that can empower students and through the Cloud, individualise learning. Despite this potential, European education, for instance in science, history, economics, geography, social studies, media and ICT, has so far, by and large, ignored Digital Earth developments. This is despite the fact that geo-technology has become a significant employer and geoinformation and geo-media have become almost ubiquitous commodities accessible from mobile, tablet and laptop.

In school education, the use of geo-media can help students construct concepts and promote a meaningful understanding of our world through problem solving, experimentation, project work and the communication of findings to others. The visual elements offered by geo-media are essential for enquiry, exploration and communication. However, here are only small pockets of intense activity and geo-media education in Europe has generally lagged behind, especially concerning schools and teacher training. This paper reports on an initiative to establish, develop and promote the concept of Digital Earth education for schools and teacher education and training across Europe.

2. CREATING A DIGITAL-EARTH.EU EUROPEAN NETWORK

2.1 Developing a Digital Earth European Centre

Research has confirmed that in Europe there had been little or no attention paid to the significance of emerging geospatial technologies in schools. A few pilot projects have created teaching resources in several languages and training courses have successfully been delivered to relatively small numbers of educators across the continent. Large-scale, ministerial-initiated implementation was generally lacking, indicating that European education has generally been unable to keep pace with technological and societal changes taking place.

In response to geo-spatial developments an Austrian Centre for geo-media education (digital:earth:at) was created in Salzburg, linking a number of organisations who were working with schools and teachers. The goal was to share resources, tools and innovative ideas to increase the use of geo-media with Austrian pupils and teachers. Its successful implementation resulted in the development of a proposal for a European networking initiative, called digital-earth.eu, connecting stakeholders across the continent. A network consisting of 47 partners from 18 countries was formed and funding obtained for them to work together for three years (2010-2013) under the Lifelong Learning Comenius Programme. The digital-earth.eu Comenius network sought to raise awareness of the many innovative 'geospatial' developments taking place and reflect on their implication and potential impact in school education systems.

An early focus of the digital-earth.eu project was the founding of a European Centre in November 2011, based at the Austrian Centre of Excellence with the aim to build a Community of Practice that could support teachers in different parts of Europe, and connect people working in national and regional contexts. The purpose was to generate a European infrastructure that would allow those involved to share ideas and information, communicate future visions and develop an informed Community of Practice (CoP). The CoP would be based on the development of a network of accredited expert centres for geo-media across Europe. Following an open Call for experts, the evaluation of proposed Centres of Excellence was undertaken through a peer review process and accredited by the European Centre and the European Association of Geographers (EUROGEO). These expert centres form multipliers by working with many teachers and trainers in their own situations. They are able to offer advice and guidance to stakeholders such as Ministries of Education. This process offers increased visibility to organisations that are doing outstanding work. It encourages and supports innovation in learning and teaching approaches and rewards quality. At the time of writing this article, fourteen Centres in thirteen European countries have been established and several others are going through the review process.
2.2 Special Interest Groups

The issues dealt with by the digital-earth.eu project are very broad, including teacher training standards, professional development and geomedia competences. They have considered issues of data availability following the results of the EU INSPIRE initiative and the tools available for educators to use. The network was organised into four thematic special interest groups (SIGs) concerned with:

1. Data, Tools and Technologies
2. Learning and teaching environments
3. Teacher Education and Training
4. Curriculum developments

Each of these groups have reviewed the state of the art and contributed to an online catalogue of materials, courses, publications, links and best practice scenarios. They have also produced a series of research papers, publications and guidance materials. These keep teachers up-to-date with developments, resources and advice.

A needs analysis of network partners showed that while technical advances have extended the Digital Earth vision in scientific terms, in education their uses are still mostly restricted to a few users within schools and teacher training. There has been an explosion in the number of geospatial Web 2.0 tools available for teachers to use with their students, yet digital earth technologies were not widely described in national curricula. Most European Ministries of Education and even the European Commissioners for Education and the Digital Agenda were largely unaware of their existence.

It is almost impossible for most teachers to keep pace with the plethora of technologies at their disposal. The Data, Tools and Technologies SIG identified many of these resources and promoted their availability in school and teacher training contexts. These included social media, media content like RSS feeds, blogs and video clips, open apps freely available to download for mobile devices, mashup interfaces that allow interactive on-the-fly mapping, sophisticated visualisations and geo-collaborative activities developed via distributed Cloud-based, Web GIS.

SIG 1 has explored some educational perspectives of the outcomes of the European INSPIRE initiative and examined the possible impacts for teaching in schools and in teacher education. They considered data availability, standards and interoperability and addressed property rights from a school perspective, producing advice to inform teachers and teacher educators. It resulted in a series of recommendations for action. A report was produced which explored issues of copyright, Intellectual Property, standardisation and quality issues concerning data and information in different European countries relating to schools and teachers. Volunteered geographic information and crowdsourcing were examined as interesting alternatives to traditional information sources from mapping agencies and companies. An online searchable catalogue of resources has been created which provides an infrastructure through which links to resources, data, information and teaching materials.

Digital earth technologies can be used in education as a medium to encourage enquiry, enhance communication, construct personalized teaching materials, and assist students’ self-expression. The second working group (SIG 2: Learning Environments) looked at learning and teaching issues connected with the use of geo-media in schools. There are many different aspects that can play a determining role in successful learning. Their focus was on student-centred learning approaches, using geo-media in transmissive, dialogic, constructivist and co-constructive ways, so that teachers are able to encourage guided enquiry in their classrooms. The role of digital storytelling opportunities was considered highly significant, encouraged by Web 2.0 tools and communications technologies.

Digital earth technology offers opportunities for meaningful, deep learning experiences in and beyond schools. It contributes to teaching and learning by supporting exploration and experimentation, it improves motivation and learner engagement and offers the learners more responsibility and control through individual and group communication. The research undertaken confirmed that European education must focus on spatial thinking, so that learners will understand spatial patterns, linkages, and relationships.
SIG 2 has reported on key competences in the use of geo-media, examining the concept of geo-media literacy. It made recommendations for the inclusion of spatial competences, like spatial citizenship³, as key competences for lifelong learning. The group then undertook a review of learning and teaching approaches and provided practical guidance for teachers and teacher educators. A book publication (in press) will introduce different learning and teaching approaches to teaching with geo-media and geoinformation by examining comparative methods and including exemplars to highlight best practice. This publication will be connected to a conference dealing with aspects of elearning, geomedia and spatial citizenship in teacher education and schools.

The third special interest group addressed the needs of pre- and in-service teacher education. Teachers are key to an effective use of computers in the education system²⁴. Kerski⁸ discussed the important role teachers play in using key technologies to prepare students to be tomorrow’s decision makers, where they are able to tackle local, regional, and global 21st century issues. He suggests developing positive attitudes towards using technology in education is essential. Research by Teo et al., ²⁵ confirms this and has shown that a teacher's attitude towards new technologies is a major predictor of its successful use.

The Teacher Education and Training report produced by the group reviewed the state of teacher training and geo-media and made recommendations for benchmarking. It confirmed support must be offered to help teachers develop positive attitudes toward computers²⁶. To achieve this, the group created a European Centre for teaching and training in geo-media. A business plan was produced to establish an infrastructure of Centres of Excellence across Europe to support teachers and trainers at grassroots level. The group also looked at quality enhancement issues in training and the formulation of an agreed terminology and a benchmark statement for geo-media. Research was undertaken to report on teacher accreditation across Europe²⁷ and the opportunities for certification and accreditation in geoinformation. A booklet for teacher training has been produced to offer a checklist and guidance on incorporating geomedia/GI for those training teachers. It will deal with in-service training and continuing professional development of teachers.

Educational technology plays an important role in moving from teacher-centred learning activities to student-centred learning activities²⁸. Therefore, having trained teachers who are competent in using and managing educational technology is essential²⁹. SIG 3 confirmed the main challenge remains to convince education management stakeholders across Europe that the adoption of digital earth tools in their classrooms and training sessions will both enhance the way they work as well as improve their effectiveness as teachers.

The final special interest group (SIG4: Curriculum development) has been examining curriculum opportunities for using geo-media and geoinformation in schools. Most teachers have a strong sense of subject identity and are influenced by disciplinary concerns, but as Kerski⁸ suggests, today's main challenges lie with the general structure of our educational systems. Geo-media applications tend to provide cross-curricular opportunities challenging traditional curriculum development. SIG 4 are developing a series of case studies of best practice, gathered through the Centres of Excellence and from earlier projects and initiatives to illustrate how to open access to the use of geodata to pupils and students. This publication will provide examples in main curriculum areas, including Mathematics, Languages, Science, History, Economics and Geography. It will illustrate some techniques used to engage pupils and some of the outcomes from the classroom. The group also produced resources that target curriculum creators and programme developers, to advise and guide those involved in developing curricula, creating courses and lessons using geo-media. It also examined professional connections and links between schools and enterprise.

### 3. DIGITAL-EARTH.EU ACHIEVEMENTS

#### 3.1 Partnership, building a Community of Practice

The European Centre has developed the digital-earth.eu network to reach out to other important target audiences across Europe trans-nationally. By early 2013 the original partnership of 47 organisations from 18 countries in 2010 had expanded to 89 partners from 22 countries. The digital-earth.eu consortium constitutes different types of organisations and institutions operating in diverse domains and in different ways. The partnership has educational and research organisations (universities), small, medium enterprises, subject thematic associations, teacher training institutions, NGOs and a national Board of Education. These varied consortium organisations are closely connected to different target
groups, enabling direct communication with them according to their own contacts and networks. Partners have reached out to particular stakeholders using the most suitable communications channels. Consideration of the specific character of each partner will be an aspect of dissemination planning from an early stage by creating an optimum and effective dissemination planning strategy.

3.2 Dealing with innovation and change

Digital-earth.eu is working in a rapidly changing social and educational environment. The management of change in education will become very significant if we are to embrace Digital Earth environments that encourage personalized learning. It is clear the adoption, adaptation and integration of geo-media in education cannot currently keep pace with the rapid growth of geo-technologies. Projects like digital-earth.eu are essential for the future of the industry if education is to match the rapidly increasing demands for a geospatial workforce. In future school-to-career developments will be needed if geospatial industry development is to be continued and the increasing demand for geo-media professionals can be met.

During the past 24 months, more than 2,100 new geospatial education developments have been identified from the work of Comenius network and communicated on Twitter (https://twitter.com/digitaleartheu) and LinkedIn. These included new innovative tools, data sources, curriculum materials, learning and teaching developments, case studies and publications. It is therefore challenging to provide any ‘comprehensive’, up-to-date system of in-service support and initial teacher education for activating the potential of geospatial technologies in education.

The network established an infrastructure of Centres of Excellence who offer face-to-face and online modes of delivery to teachers, trainers and educational stakeholders. In response to this, in the future less traditional and even more flexible approaches are likely to be required and accepted, enabled by the creation of generic examples and scenarios that can be applied across countries and contexts. The provision of support, materials and conduct of courses in local languages, reflecting local/national curricula significantly lowers the threshold for the short-term target groups. Working nationally allows curriculum-relevant contexts to be developed. However, online courses and those undertaken through the Commission Comenius/Grundtvig training database encourages teachers and trainers to collaborate, in an interdisciplinary way and across the borders.

3.3 Open data, open information

Increasingly data, including information from remotely sensed images, are being made freely available and open to citizens and in new forms. Under INSPIRE and the Digital Agenda for Europe huge volumes of scientific research data is also being made publicly available and the volume of this will be even greater in the future. The geospatial sciences have been leading the way in these endeavours. Many of the new geospatial tools that encourage citizens to act as scientists are being implemented at national, European and global scales (see Earthwatch: http://www.earthwatch.org/ and EyeonEarth: http://www.eyeonearth.org) and relate location-based information to satellite imagery and aerial photography. The digital-earth.eu network has been operating at the fulcrum of this brave new ‘open science’ domain, the world of information repositories, curated data and freedom of information. The network focuses on the important need to develop advice and guidance so education is able to cope with the demands of addressing the critical and responsible use of the overload of information being made available in the social networking boom in a critical, analytical and responsible way.

3.4 European added value

Geospatial technologies use location to help make sense of scientific information. Their use, in critical, reflective ways requires the development of spatial thinking skills. This is increasingly critical for all aspects of life in Europe. These skills are an essential component of lifelong learning. Integrating Digital Earth approaches into school courses supports the formation of a democratic Europe of active, participative and responsible citizens. The digital-earth.eu network thus targets the needs of young people through European teachers and school education systems.

European added value lies in the transferability of the materials and resources involved. This is achieved by linking to spatial concepts, geo-social communication and collaboration. The use of geospatial tools in education leads to problem-based rather than place-based approaches, which allows materials and resources to be transferred to specific local
backgrounds that draw on the individual / collective experience of learners and educators. The work of the digital-earth.eu network has also connected to different school subjects, offering i) learning in interdisciplinary contexts and ii) addressing real world challenges. Digital Earth education also helps teachers (and students) to understand the diversity that is Europe and the range of complex issues faced by Europeans.

Digital-earth.eu draws on the progress made under the European INSPIRE directive, enhanced by the Digital Agenda for Europe in making public and increasingly private data available to European citizens. Increasingly European educators will be able to contextualise their activities by making use of this publicly available content to customize the learning environments they create to their specific place, school, college, youth organisation. This individualisation of learning, enabled by Cloud-based developments, requires a different paradigm and training perspective, one that is promoted by Digital Earth education.

3.5 Spreading excellence, exploiting results, disseminating knowledge

The Digital Earth concept provides a very attractive, positive, relatively well-known scientific brand. The digital-earth.eu network has been able to exploit it to widely promote the concept. This familiarity has created a significant marketing advantage, leading to increased awareness and drawing greater attention to the work of the project. The general aims of dissemination activities within digital-earth.eu project have been:

- to widely disseminate the existence of the digital-earth.eu and its special focus on geospatial technologies and Digital Earth education
- to propagate knowledge about the work of the project, its specific character, objectives and planned actions and activities to direct target audiences
- develop and maintain a user-friendly project website to keep the general public and other interested stakeholders informed about the digital-earth.edu project and its results.
- participate in thematically related international meetings, events and conferences and to organise national workshops to inform the educational community and the project’s direct target audience about the development of digital-earth.eu and
- disseminate project results and outcomes by other relevant and suitable means.

The digital-earth.eu network is dealing with a highly innovative, rapidly changing subject area in education. Widespread network dissemination has sought to reach as many relevant organisations as possible, including teacher associations, Ministries, academies and other relevant institutions. The goal has been to raise the profile of learning with digital geo-media, encouraging innovative practices and rewarding organisations and individuals displaying ‘excellence’. For example, the network has been working collaboratively with European Schoolnet and connecting with policy makers and decision takers, including European Ministries of Education. Since early 2012, digital-earth.eu has been a featured external project on their Scientix Web portal (http://tinyurl.com/bju7mn3). Further discussion over the possibilities to showcase the importance of geospatial technologies in European STEM education are being established, for example by connecting the geospatial industry with the Future Classroom Lab (http://fcl.eun.org/) hosted in Brussels at Schoolnet.

An important purpose of the digital-earth.eu network has been to influence policy makers who had already begun to connect European social and environmental developments to citizens, but not made the link with location-based technologies. Lobbying activities undertaken predominantly by the European Association of Geographers (EUROGEO) operating as a partner through digital-earth.eu have led to significant political engagement with the EC ‘Digital Agenda for Europe’ and ‘New Skills New Jobs’ initiatives. Dissemination activities promoted the incorporation of ‘education for digital earth’ into regional, national and European educational agenda.

3.6 Centres of Excellence (CoEs)

The vision of digital-earth.eu has been to create an infrastructure of Centres of Excellence in order to offer leadership in the field; provide information and influence to decision makers; develop and deliver services to the teachers, educators and other stakeholders through strategic actions and joint or collaborative activities. In turn, individual CoEs will
establish a network in their catchment areas, build a significant online presence and develop lobbying potential for the inclusion of Digital Earth concepts, content and tools in formal and informal education.

The digital-earth.eu Centres of Excellence (http://www.digital-earth.edu.net) have been validated not only based on their expertise and work with teachers and teacher trainers, but also on their potential sustainability in their own local context and environment. In some cases they are housed in public organisations like universities, teacher training institutions and Ministries of Education and Training, but other are in the private or voluntary sector. The network of Centres of Excellence decentralises dissemination and adds value at local, regional and national scales, helping trainers, teachers and educators establish and promote the right sort of learning and teaching culture in their own institutions. In the Comenius network this has provided very positive perceptions at local and national levels and allowed the CoEs to build their own lobbying power through their status.

4. FUTURE PLANS

The main objective of digital-earth.eu has been to address the use of geospatial technologies from a European perspective and bring geospatial researchers, educators and organisations together in order to advise and inform European stakeholders of the significant geospatial developments in education that have taken place in recent years. As geospatial technology provides a valuable tool for increasing inquiry-based spatial education, introducing it in teacher education and training will have a significant impact. Digital Earth education, integrated into school curricula, is part of the key to the process\(^{31}\), as well as in continuing teacher education courses necessary to help education meet the challenges of Cloud-based learning and teaching.

The digital-earth.eu Comenius network has laid a firm platform on which future projects and developments can be based. The network has identified methods, approaches and available resources for teaching and learning with geospatial media. It has promoted educational content and collected, validated and widely disseminated it to its network of partner organisations.

A three-phase action plan to develop strategic influence through the Centres of Excellence is envisaged (Figure 1). So far, the development of the CoE concept has been project-based. However it has already attracted information, advice and support from business and industry. This will be built on during the lifetime of digital-earth.edu project.

As the CoEs begin to produce outcomes and deliverables and share them across the network, they will facilitate the implementation of an effective portfolio of products and services (phase 2). Association development can trigger applications for operating funds and exploration of sponsorship. CoEs will start to evolve into more enterprise-based organisations serving stakeholders and the market as strategic assets providing sustainable leadership, management and services (phase 3). The emphasis throughout is placed on ‘expertise’ and ‘professionalism’ as strategic assets.
New curriculum guidelines and a "Centre of Excellence” approach to teacher education and training have been two essential strategies to address the challenges in raising awareness. Education systems in Europe need to adopt more innovative approaches to teacher training and to curriculum frameworks to embrace the rapidly changing scientific, geospatial education landscape. For Digital Earth education to succeed, innovative, scenario-based pedagogies will need to be developed, piloted and employed, together with the use of the right tools to enhance spatial thinking. Professional development of teachers and educators is therefore paramount, together with the creation of suitable resources and materials.

The consortium realises that if impact is to be scaled up, lobbying for Digital Earth education must continue. In addition, teacher education and training needs to switch from predominantly face-to-face to blended and online modes of delivery, using available Cloud technologies to offer anytime, anyplace, anywhere training. The digital-earth.eu partnership believes an accredited ‘Centre of Excellence’ approach can offer this, provided the training system encourages and allows experts to operate within it. Additionally, teachers have to be treated as professionals who are in control of the support they need to receive. Helping them to become more self-sufficient in determining their professional development needs is also important.

In the future digital-earth.eu must continue to use the latest Web mashup technologies allow geospatial data and remotely sensed information and data to be combined, visualised and explored. New educational scenarios can then be developed and tested. In order to do this, the digital-earth network has negotiated the use of state-of-the-art tools and technologies for its Centres of Excellence. From March 2013 onwards they have access to ArcGIS Online for organisations (http://www.esri.com/software/arcgis/arcgisonline) as a platform for sharing information, creating maps and educational products and building apps for schools and teachers to use. Using the EU Environment Agency EyeonEarth platform (http://www.eyeonearth.org), based on ArcGIS Online, offers digital-earth.eu members more opportunities to experiment with Cloud-based learning.

5. CONCLUSIONS

Originally education was fundamental to the Digital Earth concept, as Joseph Kerski (2008) commented:

“The Beijing Declaration on the Digital Earth recommended that Digital Earth ‘be promoted by scientific, educational and technological communities, industry, governments, as well as regional and international organisations’ (Xu and Chen 1999). The declaration emphasised ‘understanding the oneness of the Earth and its relevant phenomena.’ It called for ‘adequate investments and strong support in ‘scientific research and development, education and training.’” Kerski J (2008)

However educational perspectives have not received as much attention as other areas. The digital-earth.eu project is a direct extension of the original Digital Earth initiative as it raises awareness of the importance of geo-technologies and stimulates innovative uses of geo-media in schools and education across Europe. The project has attracted considerable interest from the educational researchers and community has been built to make advances in curriculum, learning and teaching approaches, teacher training and awareness of useful tools and technologies.

The digital-earth.eu network project was founded to raise awareness of geospatial education and inform politicians and Ministries of the significance of digital earth tools and technologies. It has been developed to connect organisations involved in geospatial education, so they can share practice, provide advice and guidance on the use of geographic (geo-)media to others and be a place for innovative future thinking and new initiatives.

The rise of geospatial technologies and particularly the growing availability of information and data to the citizen necessitates a reconsideration of the role and structure of ‘secondary’ education for Europe2020. Few links to everyday, scientific, technical orientated uses of geoinformation and citizen participation have so far been integrated into the education system, for example, spatial (location-based) thinking has so far largely been argued through the use of computer software and along the lines of traditionally organised subject areas. The iGuess Project (http://www.iguess.eu) confirmed that these boundaries severely limit its application in the classroom, largely due to pressures from curriculum-orientated, subject-driven content and limited access to technology.
The Digital Earth education approach implies the need for more creativity in thinking about school systems, structures, topics of study, timetable organisation and the uses of modern technologies, like mobiles and tablets, regularly available as part of our everyday lives. Full integration will require forward thinking from decision makers, who are prepared to take some ‘perceived risks’ to provide a modern, meaningful and relevant educational experience. Digital-earth.eu also suggests there will be a significant impact on the organization of individual spare time and even voluntary activities\(^{34}\). Participatory and community-based approaches such as the posting of information on social networking sites and data collected in the field by citizen scientists are already commonly in use in the voluntary sector. Developing this sort of participatory engagement in the education of young people allows teachers and students to become aware of the power of spatial thinking, geospatial tools and the use of the Web as a communicative and collaborative medium for citizens (young and less young) to engage with, through their involvement in cross-curricular, in-depth, ‘capstone-style’ projects\(^{35}\).

The growing shortages in the geospatial workforce in Europe, the significance of open data and the EU INSPIRE Directive suggests that Digital Earth education and training developments are urgently needed as part of the European Qualifications Framework\(^{36}\). European policy makers have to be made much more aware of geospatial concepts\(^{37,38}\) and then actively encouraged by stakeholders to respond to them in policy terms\(^{9}\). This calls for support from all stakeholders to help us create meaningful uses of ICT in schools through developing a “Digital Earth education for all”.

REFERENCES


