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# Virtual Science Hub: An Open Source Platform to Enrich Science Teaching

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***Abstract*—**This paper presents the Virtual Science Hub platform. It is an open source platform that combines a social network, an e-learning authoring tool, a videoconference service and a learning object repository for science teaching enrichment. These four main functionalities fit very well together. The platform was released in April 2012 and since then it has not stopped growing. Finally we present the results of the surveys conducted and the statistics gathered to validate this approach.

***Keywords*—**E-learning, platform, authoring tool, science teaching.

## I. Introduction

TWO terms are in vogue to describe the evolution of science with the Information and Communications Technologies (ICT): Cyber infrastructure and e-science [1].

E-science stands for "enhanced" science [2], in the sense of transdisciplinarity, global teams addressing large scale challenges, thanks to the use of new ICT tools and facilities. It includes topics like high performance computing, large storage of data, complex networks of sensors, broadband communications, open repositories, new instrumentation, visualization tools, etc.

Cyber infrastructure or e-Infrastructure consists of computing systems, data storage systems, advanced instruments and data repositories, visualization environments, and people, all linked by high speed networks to make possible scholarly innovation and discoveries not otherwise possible [3]. Cyber infrastructure is a term first used by the US National Science Foundation (NSF) [4], and it is typically used to refer to information technology systems that provide particularly powerful and advanced capabilities.

But this evolution in the science field does not imply a parallel evolution in the educational field. Many initiatives and projects like the ones described in the next section create Learning Object Repositories (LOR) for science and state collaborations with e-Infrastructures to contribute to the educational field.

To take a different approach the GLOBAL excursion (Extended Curriculum for Science Infrastructure Online) project was proposed and approved. Its main aim is to enrich science teaching in European schools. The tools that have been used are:

1) a social network to foster communication among teachers and scientists
2) an authoring tool to integrate e-Infrastructure resources as content units into existing teaching materials
3) a videoconference tool to perform virtual visits to e-Infrastructure centers
4) a Learning Object Repository

GLOBAL excursion project developed an educational platform to make the most of these tools. This paper will present that platform, the tools and the results obtained.

The rest of the paper is organized as follows. The next section reviews related work in the area of e-science, education and e-Infrastructures. Section III introduces the GLOBAL excursion project. Section IV describes the ViSH platform. Section V presents the main results together with a discussion about them. The last section finishes with some concluding remarks as well as an outlook on future work.

## II. Related Work

The term Open Educational Resources (OER) was first introduced by UNESCO in 2002 [5]. There are many definitions with slight differences, but one that is usually accepted is the one by William and Flora Hewlett Foundation [6]. They defined OER as "teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge".

According to Professor Asha Kanwar, President & Chief Executive Officer of the Commonwealth of Learning, the key question is no longer about the "how" of OER development. It is more about realizing the value to be derived from OER [7]. We can find many innovations and practices with OER in the university field in [7] and in higher education in [8] and [9].

Inside the OER initiatives and related to science we can find two very interesting ones:

- the Open Science Resources repository [10]. A repository and also a European Project where they propose and use a IEEE Learning Object Metadata (LOM) [11] profile for science resources [12].
- the COSMOS repository [13]. It is again both a European Project and a repository. It is defined as "An Advanced Scientific Repository for Science Teaching and Learning". It introduces not only learning objects (LOs) but also Learning Designs (LDs) [14].

Finally the PATHWAY project [15], another EU funded project, is a coordination and support action that uses both

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repositories for engaging European science teachers with the process of sharing, using and re-using science education LOs and LDs.

As stated in the introduction cyber infrastructures and e-science are evolving very quickly together as they are related and help each other [16]. This evolution can be used to improve science education. According to the NSF [17] cyber infrastructure moves us beyond the old school model of teachers/students and classrooms/labs. Ubiquitous learning environments now will encompass classrooms, laboratories, libraries, galleries, museums, zoos, workplaces, homes and many other locations.

As cyber infrastructure resources are based on high speed networks and advanced information technology systems [4] they suppose a very good opportunity for education. On the other hand teachers usually do not know where to find these resources, what to do with them or how are they used, and so they resort to traditional resources.

## III. Global Excursion

The European Commission has defined the advancement of Science, Technology, Engineering and Mathematics (STEM) related skills as one of the priorities for the period 2014-2020 [18]. Furthermore, it has shown in several reports its concern about the way science teaching is currently being performed [19]. Bearing all this in mind, and considering that cyber infrastructures are recognized by the European Commission as a key to a knowledge-based economy and social cohesion that need to have a place in education, the GLOBAL excursion project (http://www.globalexcursion-project.eu) was proposed and approved. The project started in September 2011 and will end in March 2014.

GLOBAL excursion´s main aim is to enrich science teaching in European schools. Together with end users, this project develops a common understanding, teaching use cases, as well as pedagogical and technical artifacts, providing students and their educators (teachers, parents, etc.) across Europe with a range of e-Infrastructures and access to expert knowledge on its usage for a joyful exploration of e-Science.

The e-science and e-Infrastructure providers participating in the project were initially three, the Institute for Biocomputation and Physics of Complex Systems (BIFI) from Spain, the Nanoscience Centre from the University of Cambridge (UCAM) from the United Kingdom and the Computer and Automation Research Institute (SZTAKI) from Hungary. The materials provided by these partners are based on the following topics: biotechnology and biology from BIFI, grid computing and volunteer computing from STZAKI and nanoscience from UCAM.

Taking all this into account, providing e-Infrastructure resources as content units that can be individually adapted and integrated into existing teaching materials and curricula of teachers was identified as the main challenge when the GLOBAL excursion project started.

## IV. ViSH

ViSH stands for Virtual Science Hub. It provides scientists, teachers and their pupils a package of activities, materials and tools for enabling the integration of e-Infrastructures into school curricula. All GLOBAL excursion activities take place in this platform. It is open source and the code can be found at https://github.com/ging/vish in case any developer wants to contribute or any institution or project wants to have their own instance of ViSH. It combines four main functionalities, a social network, eExcursions, eVisits and a LOR. We will explain them now. A screenshot of ViSH frontpage can be seen on Fig. 1.

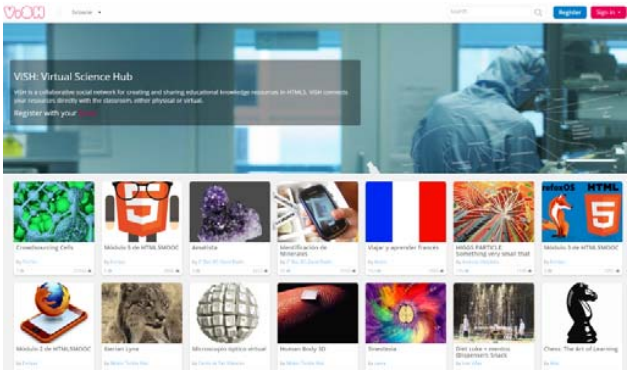


Fig. 1 ViSH frontpage

### A. Social Network

Although ViSH has been designed and developed from scratch it is based on Social Stream [20], a framework for building social network sites. It provides typical social networks features such as a timeline, user profile, following/follower relationships, private messaging, etc.

The social network main use is for teachers to meet and collaborate with scientists. But it can be also used by teachers to meet and share resources with other teachers and by scientists to meet and exchange opinions with other scientists that have interest in education and in dissemination of their results in the educational community.

To find other users that share similar interests the user profile has been enriched with tags, the organization that the user belongs to, the occupational field and an “about me” section where the user can write what he considers adequate. Also we have introduced a proactive recommendation system [21] based on these parameters and the users relations to place interesting recommendations to the users and to foster peer finding.

### B. eExcursions

Conceptually, an eExcursion, also called a Virtual Excursion, has been defined as “a tour through some digital context by teachers and pupils on a given topic that is attractive and has an educational purpose” [22].

In practice an eExcursion is an integration of LOs and resources from cyber infrastructures, external services (such as Youtube or Flikr) or uploaded by the user. eExcursions have

the appearance of slideshows, of flashcard [23], where an image with hotspots that link to other slides, or virtual maps, an interactive map with hotspots linking to other slides. An example of two slides of an eExcursion can be seen in Fig. 2.

The metadata of the eExcursions is LOM format. These eExcursions can be created with another web tool called ViSH Editor [24] and viewed with the ViSH viewer [25] using any web browser. Both tools are open source and were created in the context of the GLOBAL excursion project and integrated in ViSH.


Fig. 2 Two slides from one eExcursion
http://www.vishub.org/excursions/620

*C. eVisits*

GLOBAL excursion organized a series of "Meet the scientists" sessions, where one scientist from a cyber infrastructure joined a videoconference with teachers to tell them about his/her job, show the cyber infrastructure, share interesting resources and explain them. The sessions had a moderator and participants asked questions via an integrated chat tool. We can see an example in Fig. 3 where a scientist is explaining the parts of a butterfly wing through an electronic microscope. This is very expensive equipment, not accessible for teachers in other way.

These sessions were recorded for future revision and use. The tool used for the videoconferences was MashMe TV (http://mashme.tv). It has been also developed in the context of the project and due to the success of these sessions it has been recently integrated in ViSH to all ViSH users can perform these kind of sessions with other ViSH users or with external users as they only have to share the videoconference URL for the rest of the users to access it.


Fig. 3 A screenshot of a "Meet the scientists" session

In addition the eExcursions can be shared in the videoconference and co-browsed in a synchronous way [26].

*D. LOR*

ViSH also integrates a Learning Object Repository where users can upload any kind of resource. These resources are public to the community and any other user can use them independently or integrate them in their eExcursions. So this LOR is the support for the eExcursions.

Every resource that is uploaded to the LOR can be tagged with some metadata to be easily searched, i.e. target age, tags, name of the resource, description, language, … Also the images are resized to several sizes that will be used depending on the context and the videos are transcoded to HTML5 compatible formats so they can be seen from multiple devices.

The eExcursions created are stored in the LOR. So they can be easily searched and used without being needed to register in the platform.

Finally the LOR has a OAI-PMH target [27] so it can be harvested from external repositories that work as learning objects aggregators.

## V. Results and Discussion

Several surveys, statistics and studies have been conducted and gathered with two purposes: to improve the platform and to validate it. In this section we will present some of them.

In the first place a survey was conducted to the ViSH users after the first year of the project. 30 users from 10 different countries in Europe answered this 41 questions survey.

The survey was divided in 5 sections, the first one about themselves, the second one about usage patterns, then potential benefits and potential barriers and finally future usage and relevance.

Fig. 4 shows the results for the questions "How important is for you the fact that you can get in contact on the ViSH with …".We can see in the results that getting in contact with teachers was considered rather or very important for more than 80% of the users and more than 60% for getting in contact with scientists. These results support the social network feature of ViSH.

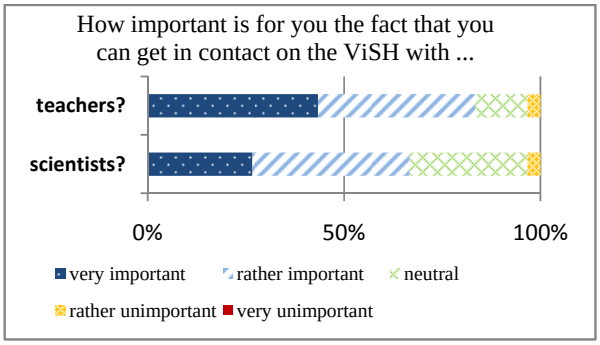


Fig. 4 Survey result

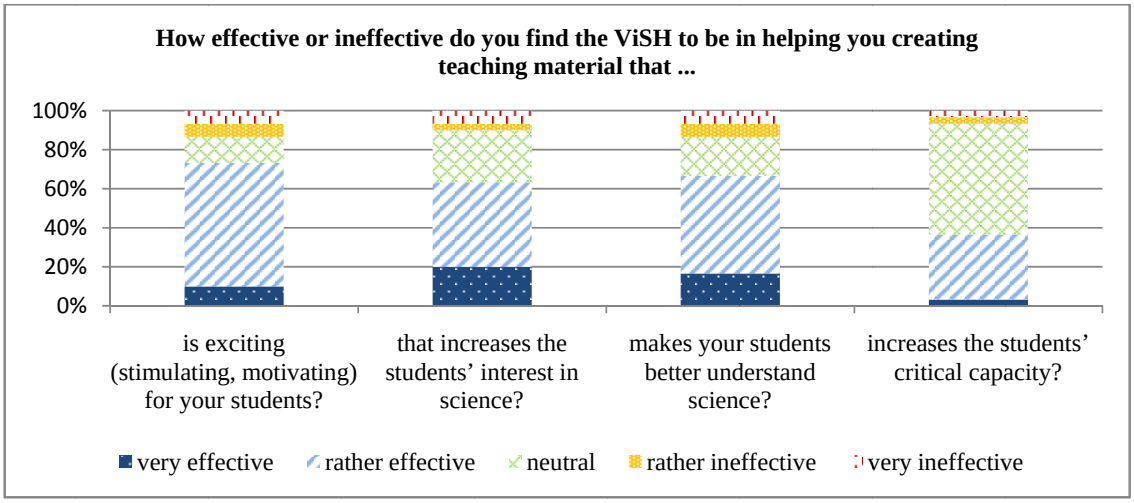


Fig. 5 Survey result

Fig. 5 shows the results for the question "How effective or ineffective do you find the ViSH to be in helping you creating teaching material that …".We can see in Fig. 5 that in the first three options the answers were more than 60% for rather or very effective. Only the option "increases the students´ critical capacity" was mainly neutral, meaning that users consider that ViSH is neither effective nor ineffective in helping creating teaching materials for that purpose. These results support the authoring tool functionality.

After the "Meet the scientists" sessions another survey was conducted among the assistants. 21 of them answered it and the results show that 20 of them "would recommend this type of session to others". To the question "The session fully achieved and matched my expectations" 9 agreed and 7 strongly agreed, 1 did not answer and 4 disagreed. Something similar happened with the statement "I enjoyed the session" where 11 strongly agreed, 5 agreed, 1 did not answer and 4 disagreed. We studied the cases of users that disagreed and they had technical problems and could not hear properly or got thrown out of the session several times. To solve these issues from the organizational point of view we will tell the speakers to use headphones and so not introduce any noise or echo and from the technical point of view we think the solution would be to introduce a low bandwidth option in MashMe TV. These results support the eVisits functionality.

Regarding statistics Fig. 6 shows the number of eExcursions created and Fig. 7 shows the number of users registered in the platform. In both cases we can see a rising trend. But even more important is the number of visits shown in Fig. 8. It shows that a lot of users access the platform to consume resources and not to produce them as happens in most social networks and authoring tools. This is possible because everything in ViSH is public by default. These results support the LOR functionality.

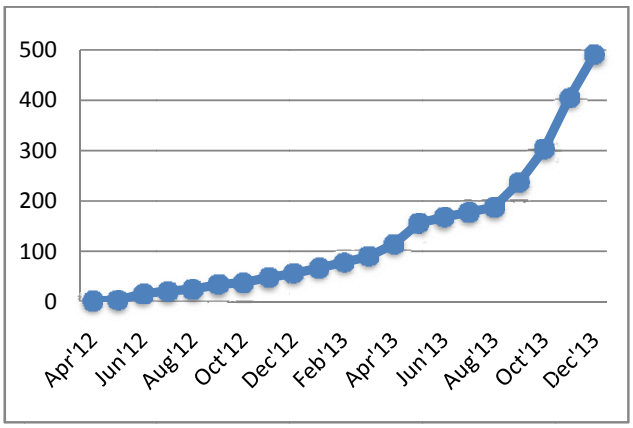


Fig. 6 Number of eExcursions (cumulative)

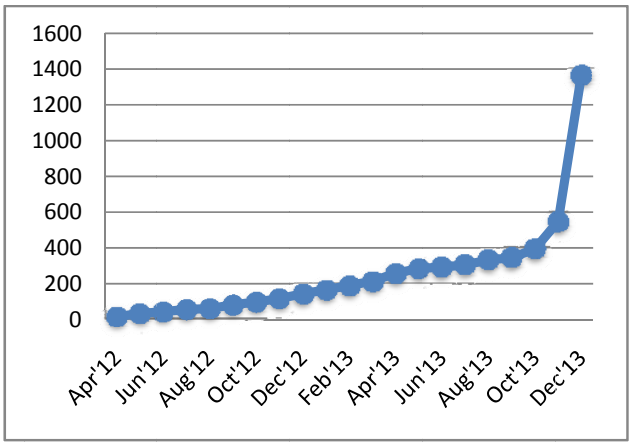


Fig. 7 Number of users (cumulative)

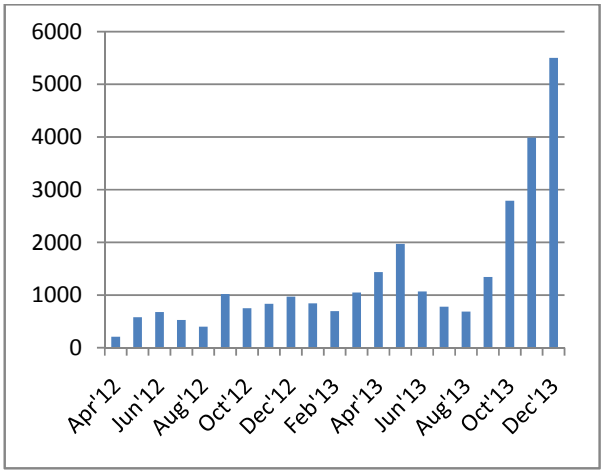


Fig. 8 Number of visits to ViSH

## VI. Conclusions and Future Work

This paper presents the Virtual Science Hub, ViSH. It is an open source platform developed in the context of the GLOBAL excursion European project. ViSH main aim is to enable the integration of e-Infrastructures in the school curricula.

ViSH is based on three pillars: a social network for teachers and scientists to meet and collaborate, an authoring tool to create educational contents and videoconference capabilities to virtually visit the e-Infrastructures, see the scientists and talk to them. Each one of the functionalities attracts different kind of users that meet in the platform.

Two surveys and some statistics were conducted and gathered to validate this approach. The results show that the three main functionalities fit very well together and that the platform is very promising.

Finally, the GLOBAL excursion still has 5 months until the end and so some activities will be done in this period. Most of them will be related to dissemination of the platform, with reviews, flyers, workshops and competitions. After the project ends the main activities will be about sustainability.

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