IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 17, Issue 1, Ver. V (Jan – Feb. 2015), PP 75-82
www.iosrjournals.org

Effectiveness of Information Communication Technologies for Education System

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Abstract: *Information and Communication Technology (ICT) provides important overview guidance for designing and implementing education programs that use technology. The principles and indicators are primarily meant to guide program designs, including the development of requests for and subsequent review of proposals, the implementation of program activities, and the development of performance management plans, evaluations, and research studies. Across the past twenty years the use of Information Communication Technology (ICT) has basically changed all forms of endeavor within business, governance and off-course education. ICT has begun to have a presence but unfortunately we are lacking to achieve desired impact. The education is a socially oriented activity. It plays vital role in building the society. The quality education traditionally is associated with strong teachers having high degrees. Using ICTs in education it moved to more student –centered learning. E-learning is shared scenario, educational resources, such as course documents, videos, test-bases, courseware, and teacher information etc., across different schools. Today, more than ever, the increasing diffusion and development of new technologies are able to reinforce the field of education introducing a number of new techniques and applications. By using Web 2.0 which is augmented version of the World Wide Web gives the collaboration and sharing of knowledge and content among users. There has been a burgeoning interest in Web 2.0, both in mainstream society as well as in education. The various tools such as blogs, wikis, social networking sites, and peer-to-peer (P2P) media sharing applications gaining much popularity and traction in all sectors of the education industry. In particular, Web 2.0 is seen to hold tremendous potential for addressing the needs of large numbers of students typical in college and university classes. It enhances their learning experiences through customization, personalization, and rich opportunities for networking and collaboration. In this paper, we have attempted to evolve an end-to end E-learning infrastructure from the integration of available technologies, specifically the semantic web, the grid, collaborative and personalization tools, and knowledge management techniques. The paper reviews the existing examples of "best practice" and "good principles" in this area.*

Keywords: *Educational technology, E-Learning, Information Communication Technology (ICT), Semantic Grid E- Learning, Web 2.0.*

I. Introduction

One very simple and powerful idea may be that the world's knowledge is a public good and that technology in general, and the World Wide Web in particular, provides an extraordinary opportunity for everyone to share, use, and reuse that knowledge [1]. In fact, nothing can replace traditional classroom teaching, but e-learning complements the process and can help reach out to the masses. Albert Lewis, Head, Products, Strategy and Business Excellence, Tata Interactive Services (TIS), points out that "A traditional learning structure does not guarantee the delivery of a consistent message, whereas consistency is assured in e-learning.[2]."

Objectives of ICT Implementation in Management Education:

1. Improvement in learning achievement;
2. Reduction of adult illiteracy rate, with sufficient emphasis on female literacy;
3. Expansion of provisions of basic education and training in other essential skills required by youth and adults;
4. Increased acquisition by individuals and families of the knowledge, skills and values required for better living and sound and sustainable development.

Role of ICT in Higher Education:

1. To increase variety of educational services & medium
2. To promote equal opportunities to obtain education & information.
3. To develop a system of collecting and disseminating educational information.
4. To promote technology literacy.
5. To support "Distance Learning".

6. To support sharing experience & information with others.

ICT and Millennium Development Goals:
Information and communication technologies are of paramount importance to the future of education. ICT in education initiatives that focus on the following areas are most likely to successfully contribute to meeting the Millennium Development Goals:
1. Increasing access through distance learning– ICTs can provide new and innovative means to bring educational opportunities to greater numbers of people of all ages, especially those who have historically been excluded, such as populations in rural areas, women facing social barriers, and students with disabilities.
2. Enabling a knowledge network for students– With knowledge as the crucial input for productive processes within today's economy, the efficiency by which knowledge is acquired and applied determines economic success. Effective use of ICTs can contribute to the timely transmission of information and knowledge, thereby helping education systems meet this challenge.
3. Training teachers– Large numbers of school teachers will be needed to meet the EFA and Millennium Development Goals for education. The use of ICTs can help in meeting teacher training targets. Moreover, ICTs provide opportunities to complement on the job training and continuing education for teachers.
4. Broadening the availability of quality education materials– Network technologies have the potential to increase the availability of quality educational materials. Their interactivity and global reach allow for customized sharing of knowledge, materials, and databases, quickly and cheaply over long geographic distances. Furthermore, online resources offer teachers access to a vast and diverse collection of educational materials, enabling them to design curricula that best meet the needs of their students.
5. Enhancing the efficiency and effectiveness of educational administration and policy– New technologies can help improve the quality of administrative activities and processes, including human resource management, student registration, and monitoring of student enrollment and achievement.

II. Perception on e-learning

In an annual survey report by Chartered Institute of Personnel and Development 151 The Broadway London in 2008 it has been concluded that, over half (57%) of organizations use e-learning, while nearly half tend to agree that e-learning is the most important development in training in the past few decades. The vast majority (82%) of public sector organizations use e-learning compared with just 42% of private sector companies. There is some indication that e-learning will be increasingly used as a training tool, with 29% saying that in the next three years between 25% and 50% of all training will be delivered via e-learning. More than three-quarters (79%) of respondents feel e-learning is not a substitute for classroom-based learning, while the vast majority (92%) feel that e-learning demands a new attitude to learning on the part of learners. Almost all (95%) feel that e-learning is more effective when combined with other forms of learning. [6].

III. Semantic Grid in E-Learning

The Semantic Web is a web of information which is used to process data directly and in directly by machine to improve the present Web by making Web resources machine-understandable by enriching present Web resources with machine understandable semantics . Tim Berners-Lee, director of the W3C, referred to the future of the present web as the "semantic web"– extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation[7]. It supports a common platform that allows information to be shared and reused across applications, enterprises, and community boundaries. It is based on the Resource Description Framework (RDF), which integrates a variety of applications using XML as syntax and URI for naming. The Grid [8] tries to connect a wide variety of geographically distributed resources such as Personal Computers, workstations and clusters, storage systems, data sources, databases and special purpose scientific instruments and presents them as an integrated resource, and it is a technology that makes it possible for distributed computing resources to be shared, managed, coordinated, and controlled.

The Semantic Grid [9] is an Internet-centralized interconnection environment that can effectively organize, share, cluster, fuse, and manage globally distributed resources based on the interconnection semantics. In short, the Semantic Grid vision is to achieve a high degree of easy-to-use and seamless automation in an effort to provide flexible collaborations and computations on a global scale. It takes advantage of machine-understandable knowledge on the Grid.

The basic architecture behind the World Wide Web is not capable of providing a seamless and artificially- intelligent environment required for a large scale effective and efficient E-learning implementation. Hence, several research works worldwide are focusing on resolving this issue. The concept of grid computing support for E learning has long received criticism from various quarters. Critics hold the view that the modern day WWW architectures, tools and technology support nearly every feature required by E-learning and thus incorporating the grid is largely unnecessary for E-learning support. We are studying this assertion taking into consideration the evolved form of Computer Supported Collaborative Learning (CSCL) around the world supported by grid computing. The support for dynamism in terms of resources, content and participants may be considered as a core grid based architectural feature to support effective E-learning strategies. A closer look into any E-learning based infrastructure would identify the highly dynamic pattern of its key ingredients i.e. resources (both content and computation) and participants. The management of such dynamically changing environments, being a key task of grid computing, needs to be further extended seamlessly to E-learning environments. Since both the grid and the WWW hold certain strengths as far as E-learning support is concerned, we propose to create a synergy by incorporating the so-called 'semantic grid' in E-learning. The semantic grid merges the semantic web with grid computing. Also, incorporating semantic grid in E-learning will provide the best seamless support available through a merger of the best of both paradigms.

A. Semantic Grid Based E-learning Platform

The proposed semantic grid-based framework is presented in Fig. 1. A service oriented semantic grid middleware lies at the core of Semantic grid E learning Environment. A Service Oriented Architecture will enable a loosely coupled interrelationship between Collaborative Partners (CPs) and provide a higher level of abstraction in the form of open interfaces. We propose a layered Semantic grid e learning environment stack at each Virtual Organization (VO) with two major segments corresponding to both E-learning and semantic grid applications/services. Such a layered approach gives a better understanding of interaction between the various components. This layered Service oriented architecture approach allows us to decouple the independent components of Semantic grid E learning platform. We present below a brief functional description of each of these layers.

1) E-Learning Application Layer

The top layer in the Semantic grid E Learning Environment VO stack will carry various end-user applications such as group and courseware managers, search facilities, scheduling and tracking software etc. Of course all of these applications will be dependent on and controlled by the specific requirements of respective end users. Possible examples of such applications could fall in the domains of E-Teaching, E Training, E-Workshop and E-Conference.

2) E-Learning Service Layer

The development of applications will be facilitated by a set of generic application-level services such as collaboration tools, agents and personalization managers. A recent application of collaboration tools and services can be seen in CoAKTing [10], which provides services such as the status of collaborative partners, discussion minutes, meeting status, things to do list, project status etc. The benefit of decoupling applications and services into separate layers is twofold. First, it will minimize reworking and increased maintainability of applications by the result of high cohesiveness and loose coupling.

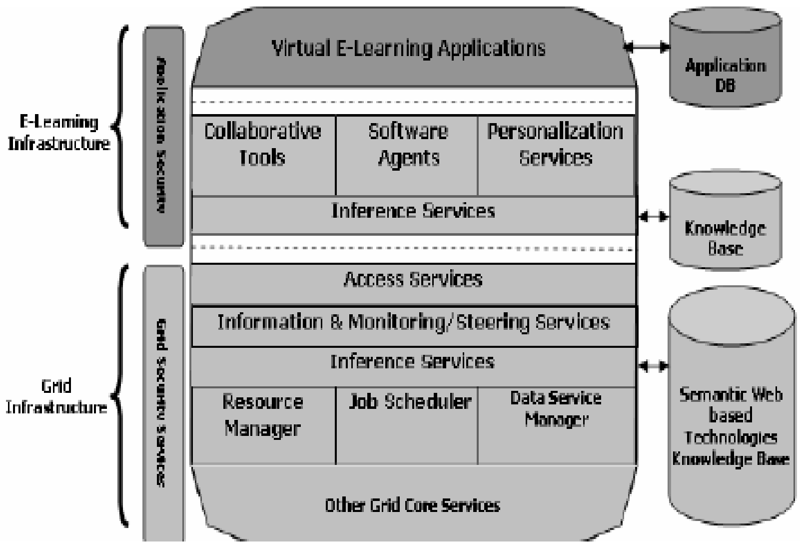

Fig. 1 Semantic grid based ELearning Platform

Second, it will also ensure compliance to some standardization criteria during application development.

Personalization Services (PS) may impart an important role by personalizing the individual centric information. That is, if someone is interested in lecture materials of some special domain, then the PS executing as a backend process will both keep track of such information based on the content usage and reduce the latency involved in information retrieval. Also, the PS can be deployed at the site level so that each individual's required information can be kept up-to-date. It could also change the traditional learning processes from strong push delivery, lack of personalization and the linear/static learning processes to efficient, distributed, student-oriented, personalized, and non-linear/dynamic learning processes [11]. Readers interested in a detailed comparison of the characteristics of traditional learning process vis-à-vis E-learning process are referred to [11]. The PS will be based on specific policies and indexing approaches determined by the interest of users (either defined explicitly by the users or inferred through usage patterns).A common theme among E-learning applications in a collaborative environment is to provide intelligent search, matching and inference support. Our basic hypothesis in this regard is that a small set of generic inference services can cater for a large number of applications. A typology of the proposed inference services is shown in Fig. 2.

Resource and content matching becomes a major issue since the use of a description language still does not standardize services and content description to the extent where a direct string-based matching can be applied. We believe that the required matching fits nicely in to the problem of semantic data matching from the information theory paradigm. Also known as in-exact data matching, semantic data matching as the name suggests is matching on the basis of semantics or meanings of data rather than its character or literal formation. Probably the most successful application of semantic data matching is in the web search engines where terms and documents are co clustered on the basis of semantics.

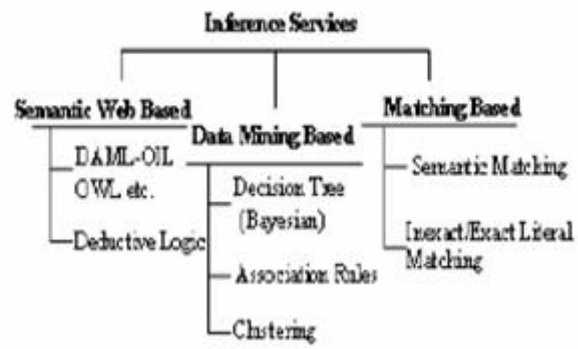

Fig. 2 A topology of inferences services

Latent Semantic Analysis (LSA) is a powerful semantic matching technique [12]. It is used to extract semantic similarity between pieces of textual information using statistical techniques. Similarly, there also exist other techniques, which involve graphical classification of the concepts and then semantic matching based on set theory and AI concepts [11]. A significant body of work could be found in the literature where such semantic or inexact matching techniques are proposed or applied to the grid domain [13, 14]. Although it is very challenging to integrate all the inference services together in one framework because of the interoperability issues, the advantages are that it will further strengthen the Semantic grid for information retrieval. To ensure appropriate support for the inference services each VO must maintain a knowledge base (e.g. for educational applications a repository of lectures, videos, tutorials, experiment designs and results and proof of experiments etc.). This may be done by deploying an artifact management system [15], which will maintain the documentation, processes, researcher or tutor profiles for future reuse. Since different ethnic groups from heterogeneous locations will be sharing their logical resources in a collaborative E-Learning environment, there must be some comparable standardized form of lectures, tutorials, videos etc. This could enable Collaborative Partners to be compliant within a shared environment. Some standards like the Educational Modeling Language (EML) from the Open University of Netherlands, IMS Enterprise Services for managed learning environments [15] already exist.

The following list may be considered as a minimal set of parameters required for an "exact" information search approximately equivalent to the IEEE Learning Object Metadata (LOM) model. These parameters could best be defined using ontologies from the semantic web domain.

a) **Domain:** the major category of related material, whether it belongs to medical sciences, computer sciences, astronomy or any other domain.
b) **Type:** the type of document e.g. ppt, pdf, doc, avi, wav
c) **Author:** the author(s) who generated a resource.
d) **Size/Capacity:** the total size of a resource. If it is a document then this is measured in bytes or if it is some computational resource then its computation power in Hz.
e) **Location:** the address/location of the resource.

f) **Description:** the short description of a resource.
g) **Constraints:** the basic requirements like security restrictions or specific tools to execute a specific request. This list can be extended based on domain-specific requirements of the users.

IV. Ontology-based Education Grid System for E-Learning

OntoEdu, a project of the University of Peking, China, is the most recent work wherein an ontology based grid is proposed for educational applications. Using educational technologies at its crux, the OntoEdu architecture realized concept reusability with ontology, device and user adaptability with ubiquitous computing and automatic composition. Although the OntoEdu architecture is quite innovative and extensive in nature, its primary focus is oriented towards adaptability (personalization). Designers have not referred to the incorporation of some equally important areas such as special collaboration tools or services and intelligent search and matching agents.

V. Collaborative Advanced Knowledge Technologies in the Grid

CoAKTing provides a motivating example of the incorporation of collaborating technologies on top of a grid structure. Geared towards academic and intellectual collaborations, CoAKTing is a set of collaborating tools that enables enhanced process tracking and navigation of resources before, after, and during meetings in progress. These tools work through a shared ontology and could be integrated in an existing collaborative environments (such as the Access Grid). Each of the CoAKTinG tools can be thought of as extracting structure from the collaboration process .The CoAKTing project has introduced tools such as Buddy Space for presence awareness, Compendium for keeping track of a bundle of ideas, issues and conceptual

Inter relationships involved in projects, I-X Process Panels and Meeting Replay. Interested readers are referred to and for more details on working and features of these tools. The set of CoAKTing tools can be useful at collaboration services layer of semantic grid learning. We agree, with where they summarize that 'the CoAKTinG tools can be transposed into the Learning Grid'.

VI. APPLE: A Novel P2P based e-Learning Environment

The APPLE (A novel P2P based e-Learning Environment) project emphasizes the importance of grid and P2P infrastructures for e-Learning applications instead of a static web. This work proposes the use of the grid for group-centric and P2P for individual-centric information retrieval. The designers of APPLE used WSRF.NET to develop and deploy a virtual classroom service. They integrated a P2P platform with the grid to exploit extensive resource potential from the grid. Despite being an extensive framework, a major limitation of APPLE seems to be its dependency on a proprietary Microsoft technology (WSRF.NET). Moreover, intelligent semantic matching structures, personalization and collaboration technologies have not been explicitly addressed in the original APPLE proposal. In a larger sense, the use of P2P (as in APPLE) or the Grid have similar final objectives — the pooling and coordinated use of large sets of distributed resources. These technologies work with the same approach to solving the problems but target different communities, resources and applications. In an important paper, Foster states that the complementary nature of the strengths and weaknesses of the two approaches suggests that the interests of the two communities (grid and P2P) are likely to grow closer over time. In the same spirit, the designers of APPLE incorporate the strengths of both technologies by adopting hybrid architecture.

The Semantic grid E Learning environment philosophy further enhances this approach by introducing the semantic grid based underlying middleware with reasoning support for easy service discovery and request submission, software agents for intelligent negotiation and collaborating tools for the purpose of collaborative activities like meetings, things to do list etc.

VII. Other Related Works

An exciting work in collaborative learning is the Access Grid project of Argonne National Labs .Currently deployed at 150 institutions around the world, the Access Grid is a multicast videoconference technology that enables its users to conduct real-time virtual conferences and maintain a wholesome online groupware. Boldyreff have explored the concept of shared artifacts over the grid. All the resources, such as documentation including architectural details, design documents, test cases, process definitions and details, researcher or partner profiles are considered to be the artifacts which can be shared for future reuse over the grid. Boldyreff. also made an effective analogy between collaborative software development and collaborative learning by highlighting the significance of shared artifacts over the grid.

Some recent works have also been reported in the domain of the integration of semantic web technologies either in the form of deploying translators or using ontology. The induction of semantics in the grid will further improve the collaborative efforts in different domains. Large scale projects including DILIGENT and BRICKS are underway for the integration of digital libraries for collaborative heterogeneous knowledge sharing within grid environments.

VIII. Impact of Web 2.0 in E-Learning

Generally the knowledge about Web 2.0 and its concepts seems to be still relatively low in the general population. A survey was conducted at the IICM aiming to analyze the use of Web 2.0 applications privately and for learning, taking into account the familiarity with Web technologies [16]. The survey was conducted in June 2007 and targeted the participants of one computer science course in the first and one in the third year of the bachelor program as well as one course for master level students. In a first part of the survey the technical background knowledge and the familiarity with several Web technologies was asked for. In the second part of the survey the basic knowledge about and the frequency of use of several Web 2.0 applications was covered.

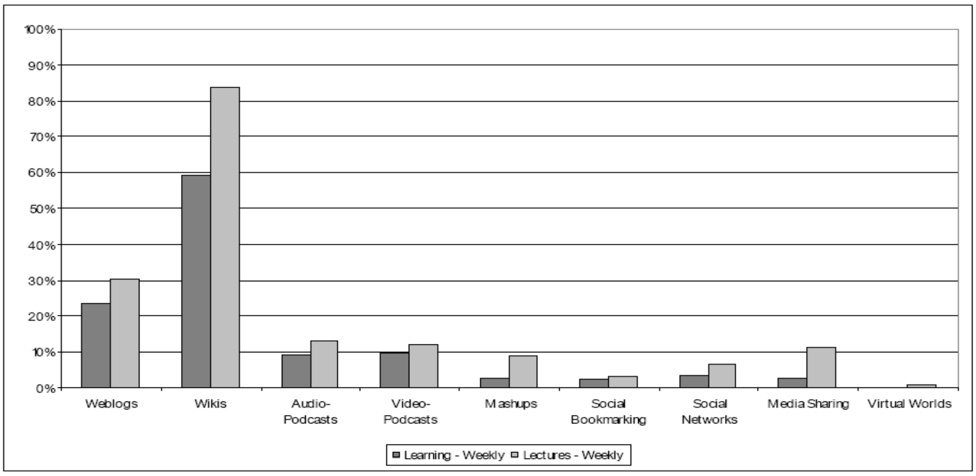

Fig. 3 Use Frequencies in Learning and Lectures

The applications in question are weblogs, wikis, audio-podcasts, video-podcasts, mashups, social bookmarking, social networks, media sharing tools and virtual worlds. Wikis, media sharing and weblogs were known by a majority of the participants (Fig. 3), while social bookmarks and social networks were known only by about 40% each. As far as general use is concerned, wikis are most frequently used with more than 80% accessing them weekly or more often. Media sharing and weblogs are used by 70% respectively 50% in the same frequency, while all other applications are used only by less than 30% weekly or more often.

A. Web 2.0 Principles and Best Practices

Consider the following raw demographic and technological drivers: One billion people around the globe now have access to the Internet Mobile devices outnumber desktop computers by a factor of two Nearly 50 percent of all U.S. Internet access is now via always-on broadband connections Combine drivers with the fundamental laws of social networks and lessons from the Web's first decade, and: In the first quarter of 2006, MySpace.com signed up 280,000 new users each day and had the second most Internet traffic By the second quarter of 2006, 50 million blogs were created—new ones were added at a rate of two per second In 2005, eBay conducted 8 billion API-based web services transactions These trends manifest themselves under a variety of guises, names, and technologies: social computing, user-generated content, software as a service, podcasting, blogs, and the read–write web. Taken together, they are Web 2.0, the next-generation, user driven, intelligent web [17].

For development organizations, this shift impacts the entire software development and delivery process. Success now relies on adoption of the perpetual beta development model in which software is continuously refined and improved, users become co-developers, and operations—the daily care and feeding of online services become a core competency. It is Web Development 2.0. The benefits are as follows: Faster time to market, Reduced risk, Closer relationship with customers, Real-time data to make quantifiable decisions, Increased responsiveness.

B. Best Practices

1) Release early and release often

This edict of the open source development model is now a critical success factor for Internet-based software. Use agile and iterative development methodologies to package bug fixes and enhancements into incremental releases that respond to user feedback. Use automated testing and a rigorous build and deploy process to streamline QA and release management. eBay deploys a new version of its service approximately every two weeks. Flickr photo-sharing service took this even further, deploying hundreds of incremental releases during an 18 month period from February 2004 through August 2005. Compare this with the traditional product release cycle as exemplified by Microsoft Windows.

2) **Engage users as co-developers and real-time testers**
3) **Instrument your product**
4) **Make operations a core competency**
5) **Use dynamic tools and languages** Rapid release cycles and agile, responsive development models benefit from appropriately flexible development tools and languages. Employ platform-independent, dynamic languages such as Python, PHP, and Ruby to enable adaptability to change, speed, and productivity.

IX. Conclusion

The role of ICTs in the education is recurring and unavoidable. Rapid changes in the technologies are indicating that the role of ICT in future will grow tremendously in the education. An effective, end-to-end and practical E-learning environment cannot be realized from a loose integration of available technologies or by starting the development from scratch. Tim O'Reilly has coined the term "Web 2.0" for collaborative, user-centric content production and interactive content access. Web 2.0 has been merged into the e-learning domain. Generation of e-learning summarized. A survey concludes that almost all (95%) feel that e-learning is more effective when combined with other forms of learning. Wikis allow all users to create and edit content online. Wikipedia is the best known wiki system. The key feature of a blog is the presentation of the content in reverse chronological order. Blogs are a personal form of publishing content. A technological and social aspect of web 2.0 has been discussed. Wikis, media sharing and weblogs were known by a majority of the people, while social bookmarks and social networks are less known to the people.

X. Future Scope

In order to make E-learning above the imagination reality, a number of research challenges need to be addressed. These include

- Integrated Media. Research into incorporating a wide range of media into the e-Science infrastructure. This will include video, audio, and a wide range of imaging methods. Research is also needed into the association of metadata and annotation with these various media forms.
- Content Presentation. Research is required into methods and techniques that allow content to be visualized in ways consistent with the e-Science collaborative effort. This will also involve customizing content in ways that reflect localized context and should allow for personalization and adaptation.
- E-Science Workflow and Collaboration. Much more needs to be done to understand the workflow of current and future e-Science collaborations. Users should be able to form, maintain and disband communities of practice with restricted membership criteria and rules of operation. Currently most studies focus on the e-Science infrastructure behind the socket on the wall. However this infrastructure will not be used unless it fits in with the working environment of the e-Scientists. This process has not been studied explicitly and there is a pressing need to gather and understand these requirements. There is a need to collect real requirements from users, to collect use cases and to engage in some evaluative and comparative work. There is also a need to more fully understand the process of collaboration in e-Science.
- Pervasive E-Science. Currently most references and discussions about grids imply that their primary task is to enable global access to huge amounts of computational power. Generically, however, we believe grids should be thought of as the means of providing seamless and transparent access from and to a diverse set of networked resources. These resources can range from PDAs to supercomputers and from sensors and smart laboratories to satellite feeds.
- E-Anything. Many of the issues, technologies and solutions developed in the context of e-Science can be exploited in other domains where groups of diverse stakeholders need to come together electronically and interact in flexible ways.

Thus it is important that relationships are established and exploitation routes are explored with domains such as e-Business, e-Commerce, e-Education, and e-Entertainment.

References

[1]. Per Bergamin, a presentation on "Some lessons to learn from the OER-Movement?", Online Available: *www.ifel.ch.*
[2]. http://www.expresscomputeronline.com/20051114/market03.shtml
[3]. O'Reilly T.; What Is Web 2.0 - Design Patterns and Business Models for the Next Generation of Software, 2005, Online Available: http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html.
[4]. Alexander B.;Web 2.0: A New Wave of Innovation for Teaching and Learning? EDUCAUSE Review, vol. 41, no. 2 (March/April 2006): 32–44, 2006.

[5]. Downes S.; E-learning 2.0, ACM eLearn Magazine, 2005., Online Available: http://www.elearnmag.org/subpage.cfm?section=articles&article=29-1.

[6]. Annual survey report 2008, by Chartered Institute of Personnel and Development 151 The Broadway London SW19 1JQ Tel: 020 8612 6200 Fax: 020 8612 6201 Email: cipd@cipd.co.uk Website: www.cipd.co.u

[7]. Huajun Chen, Zhaohui Wu, and Jiefeng Xu" KB-Grid: Towards Building Large-Scale Knowledge System in Semantic Web" Springer-Verlag Berlin Heidelberg 2003.

[8]. Ioannis Kotsiopoulos, Pinar Alper, Sean Bechhofer, Oscar Corcho, Carole Goble, Dean Kuo and Paolo Missier. "Towards a Semantic Grid Architecture" 2003

[9]. Levis, K., "The Business of E-learning: A Revolution in Training and Education Markets", 2002, Report .

[10]. Shum, S.B., "CoAKTinG: Collaborative Advanced Knowledge Technologies in the Grid", Proc. Second Workshop on Advanced Collaborative Environments, Eleventh IEEE Int.Symposium on High Performance Distributed Computing.

[11]. Deborah L. et al., "Towards Explaining Semantic Matching", Technical Report # DIT-04-019, Proceedings of the Int. Workshop on Description Logics, February 2004.

[12]. Berry M.W., Dumais S.T. and O'Brien G.W., "Using Linear Algebra for Intelligent Information retrieval", SIAM review, 37(4) pp. 573-595, 1995.

[13]. Brooke J., et al., "Semantic Matching of Grid Resource Descriptions", in proceedings of 2nd European Across-Grids Conference, 2004.

[14]. Harth, Andreas et. al., "A Semantic Matchmaker Service on the Grid". In proceedings of 13th International World Wide Web Conference (WWW2004), New York, May 17-22 2004, Pages 326-327.

[15]. Boldyreff, Cornelia, et. al., "Towards Collaborative Learning via Shared Artefacts over the Grid", in proceedings of 1st LEGE-WG International Workshop on Educational Models for GRID Based Services, 16 September 2002, Lausanne, Switzerland.

[16]. Web 2.0 Principles and Best Practices John Musser with Tim O'Reilly & the O'Reilly Radar Team executive summary.

[17]. E-Learning practices and Web 2.0, Christian Safran, Denis Helic, Christian Gütl Institute for Information Systems and Computer Media, Graz University of Technology.